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VOLVULUS OF THE LARGE AND SMALL INTESTINE

WITH REPORT OF A CASE OF VOLVULUS OF CECUM, ASCENDING COLON & ILEUM*

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FORTUNATELY for mankind, volvulus of the intestine is of very rare occurrence. However when found prompt surgical treatment is imperative. Volvulus may be described as a twisting, or turning, or rotation of the bowel upon its mesenteric axis. This may result in circulatory disturbance, obstruction, peritonitis, and gangrene of the particular loop affected. Various authors attribute from 3 to 4 per cent of all intestinal obstruction to volvulus.

The small intestine with the exception of the duodenum, and the large intestine with the exception of the rectum, may become involved, although volvulus is most frequently found in the large bowel. The common sites are: the sigmoid colon, about 75 per cent of all cases are found here; the cecum; the cecum and ascending colon; the cecum, ascending colon and ileum; and the ileum alone.

Rotation of the volvulus may vary from half a circle, 180 degrees, to three complete turns. Rotation is generally clockwise. Nearly 80 per cent of all cases of volvulus are found in men, usually between the ages of forty and sixty years.

The causes of volvulus have not been very clearly determined. It is agreed that the presence of a long mesentery or mesocolon is a determining factor. But exactly what causes have produced a long mesentery? Some authors attribute volvulus to constipation, others to congenital imperfections. Adhesions following an operation, approximation of the foot points of the omega loop which we call the sigmoid or pelvic colon, a long meso-sigmoid with a narrow base, a pendulous freely movable cecum and ascending colon predispose to a volvulus. Rotation may be caused by straining at stool, injury, peristalsis induced by active purgation, and violent twisting movements. How do we account for volvulus of the cecum and ascending colon where the feces are liquid?

In the case of volvulus, the onset of abdominal pain is usually sudden and frequently occurs in a person in good health. This pain is severe and often colicky. The griping pain is due to violent peristaltic movements of the intestine caused by obstruction of the bowel. There is tenderness on pressure. Vomiting is found early when the twist is in the upper portion of the small intestine, and late when the sigmoid is involved. The abdomen is distended and may show violent peristaltic movements. The pulse, temperature and leucocyte count are usually increased, though they may not be affected for a considerable time.

It must of course be borne in mind that all these symptoms are seldom found at

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the same time. On the whole tenderness on pressure is one of the most constant and important indications of the disease, though it is also distinguished by the acute onset, tympanitic distention of the abdomen and colic without fever.

TREATMENT

Rectal enemata, given with the patient in the knee chest position, in the early stages may untwist a volvulus of the sigmoid.

In the treatment of volvulus morphia should be avoided scrupulously, as it renders the patient insensible to pain and tenderness and so hinders the surgeon in making an early and accurate diagnosis. The chief thing to be accomplished is prompt and efficient drainage of the affected loop and the intestine above the obstruction. A prolonged operation may prove fatal to the patient. Too much should not be attempted in the acute, critical stage of volvulus. The simplest operation should be performed to save the patient's life even though a second one may be foreseen.

Primary resection of the bowel with anastomosis should not be attempted unless the operator is exceptionally skillful so that the operation may be performed both quickly and accurately. A lateral anastomosis is preferable to an end-to-end union. A simple ileostomy or cecostomy may give the patient the best chance of recovery. Cecostomy may be desirable when the sigmoid is the seat of the volvulus. The Mikulicz two-stage operation, first bringing the gangrenous portion outside the abdomen, and suturing the sound ends to the wound, and then closing the fistulae at a second operation, may be the operation of choice.

To prevent recurrence of volvulus where resection is not done, Waterhouse suggests shortening the loop by suturing the mesentery in folds parallel to the axis of the intestine.

The mortality of volvulus, from 50 to 65 per cent, is appallingly high. This is due chiefly to faulty diagnosis and delayed operation. It is essential that the operation be performed promptly and expertly.

In order that we may operate promptly I feel we should do more work in the homes of people living in the country, who otherwise would have to be carried to a hospital miles away.

We have become too dependent on hospitals and routine. The young man today feels it is impossible to work unless he is surrounded by the shining tiles and conveniences of the modern hospital. But we must remember that many small community hospitals are staffed by inexperienced surgeons. We should make more of an effort therefore to help the country people, many of whom cannot go to a city hospital. In many cases also delay is fatal.

The case I am going to report is one of volvulus of the cecum, 8 inches of the ascending colon, and 6 inches of the ileum, which occurred in a young woman aged twenty-one, seven months pregnant. I have thought that it might be of interest to know how things were done thirty years ago.

Dr. Lace of Pascoag, a town about twenty miles from Providence, asked me to see a patient, a young woman, ill two days, who required an operation for acute appendicitis. As these were pre-automobile days my assistant, a trained nurse, and myself with a large kit bag made the train. This bag contained sterile sheets, towels, gauze sponges, sutures of various kinds, and instruments to enable one to deal with any abdominal condition requiring operation.

Upon reaching the cottage, I found a woman, twenty-one years old, married one year, seven months pregnant, abdomen distended by the pregnancy and the results of acute peritonitis, pulse rapid, temperature 101°F., pain on pressure most marked in the right iliac region. She had previously been nauseated and had vomited.

We all thought that we had to deal with an acute appendicitis, so we made preparations to operate.

The dining table served as the operating table; the time-honored wash boiler as the

sterilizer. In the wash boiler three-quarters full of water were placed two large pitchers and basins, such as yet may be found in country hotels, and the instruments and sutures wrapped in a canvas roll. This roll was tied with a bandage, one end of which was left outside the boiler to enable one to lift out the hot package. One of the pitchers was filled with hot water, a sterile towel tied over the top, and set outside to cool. The other pitcher contained hot sterile water taken from the wash boiler. Two nickel trays were sterilized by igniting a small quantity of alcohol poured into them. Then the sterile instruments were placed in these trays in a hot 1:40 carbolic solution.

Dr. Lace administered ether. The abdomen was scrubbed with a 1:2000 bichloride of mercury solution. A right iliac, muscle splitting incision was made allowing entrance to the abdominal cavity. A black, largely distended mass of intestine presented and was withdrawn outside the abdominal cavity. This proved to be the cecum, the appendix, 6 inches of the terminal ileum, and 8 inches of the ascending colon. This loop of the intestine at the site of the mesentery was twisted to the right once and a half around, thus constricting the blood supply to the bowel. The loop of intestine was untwisted, but no color returned when the pressure on the vessels was relieved and an incision was made in the colon releasing dark liquid fetid contents. However the loop was left hanging outside the wound with the possibility of a return of the circulation. Sound portions of the ascending colon and ileum were placed parallel and stitched together with two rows of Pagenstecher thread, and these portions of bowel were sewed to muscle fascia and skin. Drains were placed in the lower part of the wound into Douglas' pouch and the right iliac fossa. The wound above the drains was united up to the exit of the two sound portions of the intestine which were sutured in the mid portion of the wound. An aseptic dressing was applied and the patient was left to the care of a real trained, motherly nurse, who not only did excellent nursing for the patient, but cooked for herself and the husband and kept the house in order, a rare combination in these days. Next day we saw the patient and no color having appeared in the loop of intestine we removed it flush with the skin and irrigated the bowel with normal salt solution through two openings, one in the colon and one in the ileum, presenting like the openings of a double-barrelled gun. The general condition of the patient was good. The fourth day Dr. Lace telephoned me that the patient had a miscarriage, the infant dying in a few hours. I saw the patient from time to time over a period of three weeks, the sutures removable had been removed, the patient was sitting up and in excellent and cheerful spirits. The closing of the fecal fistula I deemed it wise to defer for several months.

As the patient had regained her normal health and composure and had become accustomed in a measure to the presence of the fecal fistula, I had her admitted to St. Joseph's Hospital at Providence. There was some slight discharge of feces from the rectum, although most of the feces came through the opening in the end of the ileum.

Ether was administered. With one blade of a scissors in each of the bowel openings I cut the bowel walls to a depth of 2 inches between the double row of stitches I had placed to unite the walls of bowel at the time of the former operation. The mucous membrane of the bowel was dissected free, inverted and united with a continuous plain gut suture, reenforced by Cushing right-angle sutures. The bowel muscular layers were dissected free and united with catgut sutures. The muscular wall of the abdomen was then sewed over the bowel with chromic gut sutures. The margin of the skin wound near the fistulae were excised and the skin united with a continuous subdermal silkworm gut suture. A fibroid growth, the size of a pigeon's egg, was removed from the upper left quadrant of the right breast. Next day the bowels moved with the aid of calomel, magnesium sulphate and enema. Three days later the bowels moved regularly with citrate of magnesia and enemas. The eighth day the subcutaneous suture and the suture in the breast wound were removed. Primary union occurred in both.

The subsequent history follows. About a year after the second operation she was delivered of twins at full term. They both lived but a few months.

Six years later she was living in a city forty miles away, but came to see me. She said she was pregnant about eight months and had consulted a physician who told her it would be necessary to have a Cesarian section on account of her former operations. I gave her the names of three physicians in her city who

were competent and honest. Two weeks later the patient consulted me again and asked me to care for her. She was in such evident distress that I consented and she was admitted to the Providence Lying In Hospital. One day labor pains began about 10 A.M. and in two hours a robust boy was born who is living today and is a great joy to his mother. The delivery and convalescence were normal.

In conclusion I should like to point out:

1. That prompt surgical intervention in patients with volvulus is imperative.
2. That the simplest operation is best.
3. That emergency operations in the country should not become obsolete.

The surgeon should have the courage of his convictions. Time, patience and courage on his part are necessary, but many lives may thereby be saved.

My object in presenting this subject will have been attained, if I have succeeded in impressing upon you the importance of early diagnosis and prompt operative interference.

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INGUINAL AND FEMORAL HERNIA*

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THIS study is based on an experience with 806 herniorrhaphies performed by the writer on 778 patients, the results of which are reported in considerable detail in the hope of bringing out certain facts bearing on the subject of inguinal and femoral hernia and, especially, on the question of the prevention of recurrence following operation. In our follow-up investigations 619 patients answered questionnaires; most of these patients were personally re-examined, furnishing an accurate end-result check of 80 per cent of the cases.

INGUINAL HERNIA

Of the 778 patients 558 had unilateral *inguinal* hernia, 77 of the patients being females and 481 males, or a relative incidence of 14 per cent to 86 per cent. The oldest patient was eighty-eight and the youngest three months, the average age being fifty-five. The majority were engaged in strenuous labor, being miners, railroaders, farmers, carpenters, mill hands, etc. Most patients mentioned nothing in particular regarding a contributing cause; although about one-fourth referred to lifting as the probable exciting factor, next in order being a fall. The average duration of the hernia was five years, 5.9 per cent being of the direct variety, 3.9 per cent being strangulated on admission. Seven patients had been operated upon elsewhere on the opposite side; while the total number of patients who had been operated upon elsewhere for hernia and on whom we operated to repair hernias on the opposite side, or to repair recurrent hernias, was 35 or 6.3 per cent.

Symptoms: At least 70 per cent of the patients complained chiefly of a "painful lump." Of the 558 patients with inguinal hernia 14 had been incapacitated "many times"; while 22 had suffered from intermittent strangulation. One hundred and fifty, or 26.9 per cent, had worn trusses, but, in most cases, the patients had found the truss unsatisfactory. Only 50 per cent of the hernias were complete, i.e., the hernial mass extending well beyond the external ring or into the scrotum.

At operation the contents of the sac were found to be as follows:

Ileum	27 cases
Ileum and cecum	1
Ileum and sigmoid	1
Ileum and appendix	3
Appendix	2
Appendix and cecum	1
Appendix, cecum and ascending colon	1
Sigmoid	8
Sigmoid and descending colon	1
Portion of bowel involved not mentioned	2
Omentum	217
Fat (preperitoneal)	13
Fluid	2
Number of hernial sacs containing abdominal structures	279 or 50 per cent

Appendectomies were performed on about 1 per cent of the patients; while in 13 per cent masses of omentum were resected. In 22 cases, or 3.9 per cent, an undescended testicle was found; in the majority of cases it was possible to perform an operation resulting in establishment of the testicle in its normal position in the scrotum. In 6 patients the testicle, being rudimentary, was removed. In one case a tube and ovary were found within the sac, both of which were excised.

BILATERAL INGUINAL HERNIA

Of the patients with inguinal hernia there were 160, or 22 per cent, with bilateral involvement, 155 being males and 5 females. In this group over 50 per cent were

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patients who were engaged in hard physical labor, being iron workers, carpenters, railroaders, puddlers, laborers, etc. Forty patients, or 25 per cent, were wearing trusses at the time of examination, a few having obtained some relief for a short time, but all, sooner or later, complaining of great dissatisfaction with these devices. Of the 160 patients 128 had bilateral indirect inguinal hernias, 17 had bilateral direct inguinal hernias, and 15 cases were mixed. There were 2 of bilateral direct inguinal hernias which were sliding on both sides; 2 of the indirect variety were sliding on both sides and 2 bilateral indirect sliding on one side only. Of the 160 cases of bilateral inguinal hernia 8, or 5 per cent, were sliding hernias, a greater incidence of sliding hernia being found in patients with bilateral hernia. In this group of 160 cases, 5 had been operated on elsewhere and had come to us because of a recurrence.

The sac contents in order of occurrence were: omentum, fat, bladder, cecum, cecum and appendix, appendix, ileum, colon, and, occasionally, the sigmoid, although, of course, the latter is the chief finding in sliding hernia.

COMPLICATIONS

Complications following operations on these patients occurred in about 10 per cent of the cases, the largest number being in the pulmonary group, consisting of a cough with other evidences of bronchitis. Urinary retention was present as a rather frequent complication, occurring in 54 of the cases, or 9.6 per cent. Epididymitis occurred rarely, but was occasionally seen. Small hematoceles occurred in 7 cases, or 1.2 per cent, pointing to the importance of careful hemostasis in operations performed for the relief of hernia.

FEMORAL HERNIA

In the entire group of 778 patients there were 60 with femoral hernia, a proportion of 7.7 per cent femoral to 92.3 per cent inguinal, 65 per cent being females and 35 per cent males. The average age was fifty-one years. The majority of the patients were housewives. Only a few could tell exactly when the hernia occurred, or how it occurred; although a few spoke of a mass suddenly appearing following heavy lifting. Several mentioned childbirth as the possible cause. The average duration of time between the onset and the patient's appearance for treatment was sixteen years. Many of these patients, a far larger proportion than was the case with the inguinal hernia group, experienced incarceration and even strangulation, or obstruction, one or more times, femoral hernia being inclined to these secondary complications far more frequently than is the case with inguinal hernia. In the group of 60 patients with femoral hernia 13 had been troubled with strangulation one or more times; while 20, or 33 per cent, were suffering from strangulation on admission to the hospital. Some had worn trusses with satisfactory results. Of the 60 cases 2 were bilateral, the majority, however, being single and occurring more often on the right side. Ten per cent of the patients coming to us with femoral hernia had previously been operated on for actual or alleged hernia in the *inguinal* region, in certain of these cases the symptoms at that time probably being due to an unrecognized femoral hernia. In most of the cases the sac contained only omentum; although, occasionally, a loop of ileum was found. Resections were not necessary in any of the cases of strangulated femoral hernia, this being also true with the strangulated inguinal group, it being our conviction that resection is rarely necessary in the strangulated cases. We did not deem it advisable in any of our cases to resect, finding that in nearly all cases of strangulated bowel, although the color of the intestine may be quite dark, the gut is still viable; hence, only in the rarest instances, will gangrene ensue. There were no recurrences found in the follow-up study of the patients in the femoral group.

RECURRENCES

There were no recurrences in the femoral group. In the inguinal group 19 patients, or 3.4 per cent, reported recurrences but, on re-examination in a large number it was found that no actual recurrence was present; although some patients had even again resorted to trusses. In about one half of the patients reporting persisting trouble a definite recurrence, however, was found, with a final figure of 1.6 per cent for recurrence.

The longest interval of time between operation and recurrence was four and one-half years and the shortest two weeks, the average being thirteen months. Seventy-three per cent occurred within six months. The number of patients who will complain of symptoms of a suspected recurrence and who, after a re-examination, are found to have none is quite surprising; consequently, this tendency on the part of some patients must be borne in mind in any follow-up study of a group of such cases, and the patient's statements evaluated only in the light of it. No definite conclusions should be drawn as to the incidence of recurrence without a check-up examination. In the group of patients who complained of what they thought was a recurrence and who came to the hospital for re-examination, was one who had even gone to another institution to be operated upon, only to have no hernia revealed.

A certain number of patients having inguinal hernias will develop small varicoceles or hydroceles following operation. In our group there were 6 of these, the condition often being considered by the patient as a recurrence of the hernia. Recurrences which were found actually to exist occurred in a group of patients operated on some years ago, chiefly by a technique in which chromic catgut was exclusively used. In later years we have used interrupted sutures of black silk in the internal oblique in closing the inguinal canal by a modified Bassini technique, during which time the percentage of recurrence has been reduced, now being less than 1 per cent.

TREATMENT

The Bassini operation, or the modification of it as described by Watson,[1] is the procedure utilized more than all others, and, in the opinion of the authors, is the best operation we have for the treatment of inguinal hernia. Sooner or later in his career every young surgeon experiences an urge to write a paper on the technique of herniorrhaphy in which he presents some wrinkle as an original device or as an alleged improvement; yet most of them prove old and discarded schemes in a new guise. It must be borne in mind that the success of the operation depends entirely on the ability of muscle and fascia to adhere, a point about which some doubt has been felt, a typical paper on the subject being that of Seelig and Chouke,[2] whose animal experiments were conducted with a view to settling the question, their conclusion being that normal muscle will not permanently unite with fascia or ligament. Of greater significance, however, is the investigation of Koontz,[3] the results of whose researches refute the findings of Seelig and whose conclusions, after a series of experiments on dogs with careful histologic studies, are that muscle unites firmly with fascia by the union of the latter with the fibrous components of the muscle and that the internal oblique and Poupart's ligament organize solidly, when these structures are brought into apposition and held there for a sufficient length of time.

It is about these points that the whole question of failure revolves. Surgeons report their percentage of recurrences variously, and the compilation of statistics varies widely due to faulty follow-up methods and to varied statistical procedures as much as to lack of surgical skill. The percentage is often so disconcertingly high that surgeons who have never before made a careful follow-up investigation of their own hernia cases may often experience

considerable surprise and disappointment following the completion of such a study.

The frequency of recurrences has led to innumerable modifications of the original Halsted (1889) and Bassini (1890) operations, the experimenters, however, often missing the point that the trouble is not as often due to the operation *per se* as to faulty technique in the attempt to carry it out. Coley[4] has stated that in recurrent hernia he invariably finds the internal oblique firmly united to Poupart's ligament but, on the other hand, it is claimed by Seelig and Chouke that in operating for recurrent hernia Poupart's ligament is found smooth and glistening and entirely free from muscle attachments. This has been our own finding, our conclusions being that the recurrence is due to failure to establish a *firm* union between the internal oblique and Poupart's ligament with obliteration of the inguinal canal, a condition, however, resulting from faulty technique; but we disagree with Seelig that the recurrence is due to the inability of these structures to adhere. Two steps of the technique, the proper observation of which will contribute more towards assuring success than anything else in the procedure are: first, to see that all of the areolar tissue is carefully removed from Poupart's ligament and, secondly, to use suture material which will remain in place for a sufficient length of time to assure firm union between the muscle and the ligament; for this purpose we believe there is no better material than silk. If properly used and with perfect asepsis, this suture will accomplish what we expect of it and will never produce the complications, wound sinuses, etc., claimed by certain authors who seem unalterably opposed to the use of non-absorbable suture material.

MORTALITY

In the entire group of 806 operations there were 4 deaths, a mortality of 0.49 per cent. In the non-strangulated group the mortality was 0.1 per cent. In the group of cases of inguinal hernia there were 2 postoperative deaths, a mortality of 0.36 per cent, one patient being a child two years old with a strangulated hernia, who died within forty-eight hours, apparently from cardiac failure; the other a male with a scrotal hernia, the patient's death occurring on the eleventh day from cardiac failure.

There were 2 deaths in the femoral group, or 3.3 per cent: the first patient, a male, aged fifty-nine, with a strangulated femoral hernia, who died from cardiorespiratory failure on the fourth day; the second, a male aged eighty-two, who was admitted with a large femoral hernia which had been strangulated for three days. The patient developed a fecal fistula on the seventeenth day, dying of peritonitis on the twentieth. In this case a resection might have been considered, but at the time of the operation the patient's condition was too grave to permit it.

"ACCIDENTAL" HERNIA

Accidental, or so-called compensable or "acute" hernia, about which so much has been written and which, as a subject, has assumed especial importance since the establishment of state compensation laws, has been well handled in the report of Coley, Wainwright, *et al*[5] appearing in 1929. Probably, the following rules adopted by the Nevada State Commission cover the question as well as it can be covered and will be approved by most surgeons familiar with the subject.

Rule 1. Real traumatic hernia is an injury to the abdominal wall of sufficient severity to puncture or tear asunder said wall and permit the exposure or protrusion of the abdominal viscera or some part thereof. Such injury will be compensated as a temporary total disability and as partial permanent disability, depending upon the injured individual's earning capacity.

Rule 2. All other hernias, whenever occurring or discovered and whatsoever the cause, are considered to be diseases, causing incapacitating conditions of permanent partial disability, and are considered to have either existed from birth, to have been years in

formation, or both, and are not compensatory except under Rule 3.

Rule 3. All cases coming under Rule 2 in which it can be conclusively proved, first, that the immediate cause which calls attention to the presence of the hernia was sudden effort or severe strain or blow, received while in the course of employment; second, that the descent of the hernia occurred immediately following the cause; third, that the cause was accompanied or immediately followed by severe pain in the hernial region; fourth, that the above-mentioned were of such severity that they were noticed by the claimant and communicated immediately to one or more persons, are considered to be aggravations of a previous ailment or disease, and will be compensated as such for time or loss only, depending on the nature of the proof submitted and the results of the examinations.

COMMENT

There are several interesting points brought out in this study. The type of anesthetic utilized seems to have no bearing on the incidence of recurrence, in fact, but little on the progress of the case in general. In this series we used ether, nitrous oxide, spinal, local, ethylene, etc., giving each type of anesthetic a thorough trial. I am finally convinced that the ideal anesthesia for this type of work is spinal; although there are many who, for various reasons, are opposed to its use in the treatment of hernia. I feel, however, that such persons singularly fail to present valid arguments against its use. Were I to be operated on for this condition I would certainly choose spinal anesthesia, and it has been the choice of many of our professional friends on whom hernia operations have been performed in our hospital. We feel that spinal anesthesia is far better than nitrous oxide and infinitely better than local anesthesia; although we are aware this statement will not be accepted by those who are enthusiastic over local. To such persons we would suggest that they try spinal on fifteen or twenty hernia cases before they are too loud in its condemnation. Under this anesthetic the patient is infinitely more comfortable, and the operation is greatly simplified. A small amount of anesthetic is required, rarely over 50 to 75 mg. of novocaine injected into the first lumbar interspace.

We are impressed with the importance of performing a bilateral herniorrhaphy in cases where there is a definite hernia on one side with a relaxed ring on the other. Such patients, if but one side is operated upon, frequently return in two or three years with a definite hernia on the side presenting the relaxed ring at the first examination.

We believe that there is no better procedure than a slightly modified Bassini operation. Whatever the technique, care should always be taken that constriction of the cord at the internal ring does not occur, that the vascular supply to the testicle is well preserved, and that any bleeding from the cord itself is thoroughly controlled before the incision is closed. If these details are not borne in mind, testicular atrophy, or hydrocele, or both, are very likely to ensue. Erdman[6] reports hydrocele of the tunica vaginalis following operation for inguinal hernia in about 4 per cent of the cases in the New York Hospital.

I am impressed with the importance of carefully preserving the nerves, so placing them during the completion of the operation that they will not be impinged upon by sutures or by scar tissue. If this is not borne in mind, a large number of patients will, ultimately, complain of chronic pain.

Trusses should be condemned in the treatment of all but the thoroughly inoperable cases. I have found many patients wearing trusses who had no hernia whatever and who probably never did have; yet I rarely find a patient who has worn a truss with any degree of satisfaction. It is obvious that the truss should not be worn following treatment, and when it is prescribed, the surgeon must have slight confindence in the integrity of his operation.

There are certain individuals who, for reasons difficult to explain, seem especially hard to cure. One of our patients had had

three operations elsewhere before coming to our own institution; all of the operations were on one side, followed by a recurrence. The technique which had been successful in 99 per cent of the cases was carried out; yet this patient was not cured until he had been operated on four times, heavy, non-absorbable sutures finally being used. In some clinics fascial transplant sutures of the Gallie type would, in such a case, probably be resorted to. We have not cared for this technique as a routine procedure; neither do we like kangaroo tendon, our feeling being that if the patient cannot be promptly cured by a modified Bassini technique using silk sutures, he would be no better off if operated upon by a method calling for the use of these heavier materials. We are definitely in favor of silk, not being able to agree with those who state that it invariably causes trouble. We have had as few wound complications since using silk as we experienced in the days when catgut was exclusively utilized. We have not had to remove silk sutures, nor have we had a draining sinus due to silk in over 500 consecutive operations in which this material was depended upon. In this connection it is repeated that the cure of inguinal hernia depends on the complete and permanent closure of the inguinal canal, and that this condition can be achieved by the accurate and permanent apposition of the internal oblique muscle to Poupart's ligament. If these are to adhere, they must rest in intimate contact for a long time, and, therefore, non-absorbable sutures are of distinct advantage. Although Scudder[7] is opposed to the use of non-absorbable sutures, Grant[8] states that by the application of two or three non-absorbable sutures in closing the posterior wall of the canal by the Bassini technique there will be fewer recurrences, an opinion in which we completely concur.

CONCLUSIONS

1. Recurrences following adequately performed operations for inguinal hernia should not exceed 1½–2 per cent.

2. In a follow-up study of inguinal hernia many patients will report a recurrence which, on physical examination, is found not to exist.

3. Recurrences following operation for femoral hernia should rarely, if ever, occur.

4. Resection of the bowel is hardly ever necessary in strangulation, yet is indicated, of course, if gangrene is developing.

5. The modified Bassini technique is the best operation for the treatment of inguinal hernia and silk the best suture material for approximating the internal oblique muscle and Poupart's ligament.

6. Spinal is the nearest to the ideal anesthesia yet advanced in the treatment of inguinal hernia, this being especially true in the strangulated forms.

7. Mortality in non-strangulated hernia should not exceed 0.1 per cent.

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LYMPHOSARCOMA OF THE JEJUNUM*

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CHICAGO

LYMPHOSARCOMA or lymphoblastoma of the jejunum is quite a rare condition; more common is carcinoma of the jejunum.[1] The order of occurrence in the gastrointestinal tract is the ilium, cecum, jejunum, appendix, transverse colon, sigmoid colon, duodenum, and descending colon.[2]

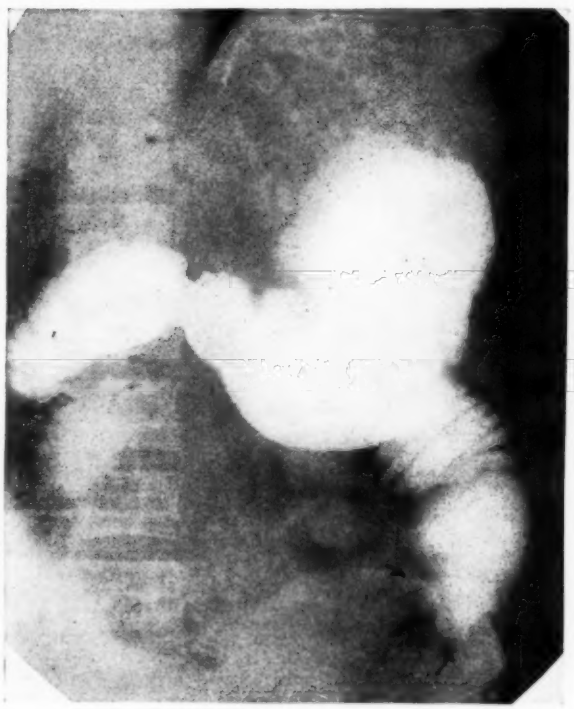

FIG. 1.

FIG. 2.

Whether or not syphilis bears any relation to lymphosarcoma, Fischer[3] states as follows: "As to whether syphilis bears an etiological relationship to the development of sarcomata, there are all sorts of opinions, from Schmidt, who remarks of sarcoma, that the luetic antecedents are not common, to von Esmarch, who states that in his clinic more than one-half of his sarcoma cases have been luetics." Fischer also states that sarcoma of the intestine may occur at any age, but mostly between the ages of thirty and forty years. Most of the cases reported have been in females. In Segal's collection of sarcoma of the intestinal tract, 34 cases in all, 19 were round-celled and 5 spindle-celled. The other tumors were alveolar or melanotic cystosarcoma, lymphosarcoma, myxosarcoma and endothelioma. Tuberculosis and sarcoma may coexist. Usually sarcoma begins in the submucosa.

Sarcoma of the intestine may reach considerable size. In counter-distinction to carcinoma, it involves a considerable portion of the bowel, and is much more likely to grow into the neighboring organs, especially the mesentery and omentum. It may also set up metastases in the liver, kidney, spleen, and retroperitoneal glands. Segal asserts that symptoms of stenosis

* Submitted for publication October 19, 1931.

occur in half the cases. Usually the neoplasm involves only the tela muscularis and mucosae, the serosa being seldom

Fig. 3.

involved. The tumor may compress the vena cava, bile passages, pancreatic duct and ureter. Ulcerations are very frequent and may lead to perforations. Mirotworzew[4] states that in cases of sarcoma of the intestine, adhesions with neighboring organs are much rarer than in carcinoma.

The typical growth of lymphosarcoma is composed of delicate reticulum in meshes of which lie cells of lymphoid character. It fails to respect the capsules of the lymph glands, but grows rapidly, involving and infiltrating adjacent tissues.[5] The intestine becomes very rigid and edematous, and the folds of mucosa are all greatly swollen.

Mirotworzew describes a typical lymphosarcoma as beginning in the submucous lymphatic glands and spreading along the intestine. If the tumor reaches the mucosa, it is under the influence of constant irritation, and thus ulcerates the walls of the intestine.[4]

The symptoms vary greatly. In most of the cases[6] the following symptoms are the most common:

1. Loss of weight.
2. Loss of appetite with or without symptoms of obstruction; therefore there may or may not be vomiting.
3. Compression of organs and vessels.
4. Pain in the epigastrium.
5. Scanty urination.
6. If obstruction is quite acute, usual symptoms of high obstruction appear and the patient becomes quite sick.
7. Local movable mass with or without tenderness.
8. Slight rise in temperature.
9. Free acid may be lower than normal or even absent.
10. Amount of gastric retention proportional to obstruction present.

It is very difficult to make an absolutely correct diagnosis, and usually this is done only at time of operation.[4] The disease must first of all be differentiated from carcinoma. The following points are highly valuable for consideration in such a differentiation. First, in cases where the *x*-ray shows constriction, carcinoma must be considered because in lymphosarcoma there may be constriction or dilatation with or without obstruction. It is interesting to note that in most of the cases *x*-ray studies were valueless, but in our case the *x*-ray pictures were very valuable. Second, pain seems to be more constant in lymphosarcoma than in carcinoma, and the mass in lymphosarcoma seems to be less fixed than in carcinoma. The disease must be differentiated from Hodgkin's disease and lymphocytic aleucemia, both of which resemble lymphosarcoma.

The treatment is, of necessity, resection and radiation, or in those cases that are inoperable, radiation alone. Bloodgood[7] makes the following very interesting statement: "The one lesion of which, as far as I know, surgery has never accomplished a cure is lymphosarcoma of the lymph glands, and apparently radium has done so. Therefore as soon as this diagnosis is established, radiation should be given and continued at intervals through the entire lymphatic gland system."

Prognosis is not very favorable. According to Fischer,[3] the postoperative mortality of these cases is very high. Death is usually due to peritonitis, and for that reason he advises drainage in all the cases. Death may result from rapid recurrence or the patient may be well from one to five years.

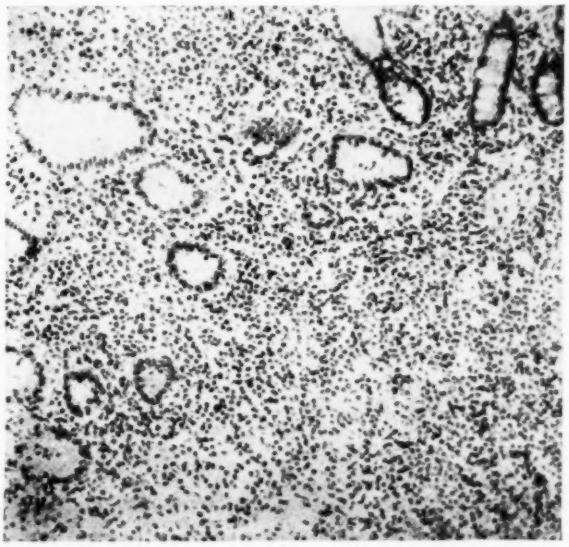

Fig. 4. Tumor cells in the mucosa (low magnification).

CASE REPORT

Mrs. N. M., forty-six years of age, entered the medical service of Dr. W. E. Cary at the Chicago Memorial Hospital February 13, 1931, giving the following history and symptoms:

1. For the past two years occasional attacks of pain in epigastrium.
2. Vomiting of green bile.
3. Loss of appetite and weight.
4. Colicky, continuous pain in epigastrium, belching, and nausea.
5. Four weeks before admittance she vomited constantly, and was unable to retain very much on stomach.
6. Obstinate constipation.
7. Past illness negative except for cholecystectomy and appendectomy eight years previous.

Examination upon admission revealed the following findings:

1. Chest and heart negative.
2. Abdomen, large, soft. Tenderness elicited almost anywhere on deep pressure. Most marked in upper right and lower left quadrants.
3. Mass felt in lower left quadrant. Palpable near midline.
4. Abdomen almost a doughy consistency.

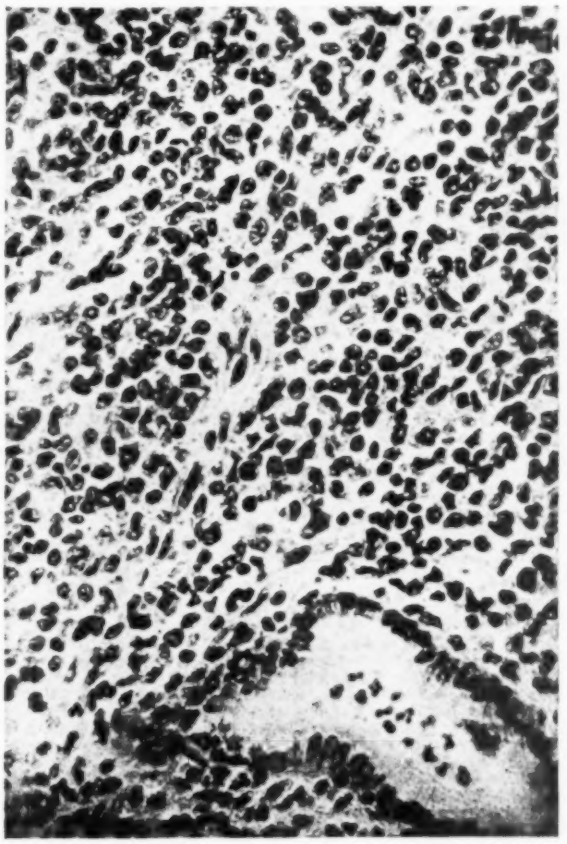

Fig. 5. Tumor cells in the mucosa (high magnification).

5. Temperature 98°F.
6. White blood count, 18,000.

During the course of the disease, the temperature varied from 98° to 103°F., white blood count varied from 13,400 to 18,000. Differential count showed 85 per cent polymorphonuclear leucocytes. Stool examination showed occult blood present. Free acid was present in the stomach content early and disappeared late in the disease. Roentgenographic findings showed a large dilated cap with distention of the entire duodenum and the first portion of the jejunum. The jejunum was almost completely obstructed and had a rather moth-eaten appearance. (Fig. 1.) The six-hour picture showed quite a bit of retention (Fig. 2). The twenty-four-hour picture showed considerable retention (Fig. 3).

The patient was transferred to my surgical service February 25, 1931. After consultation with Dr. Charles E. Kahlke, operation was

performed February 26, 1931 under local anesthesia at which time a first stage was done, bringing up the jejunal mass with a jejunostomy made both proximally and distally to tumor. March 5, a blood transfusion was done. March 7, second-stage operation was performed, at which time the tumor was resected and an end-to-end anastomosis made, with drains left in abdomen.

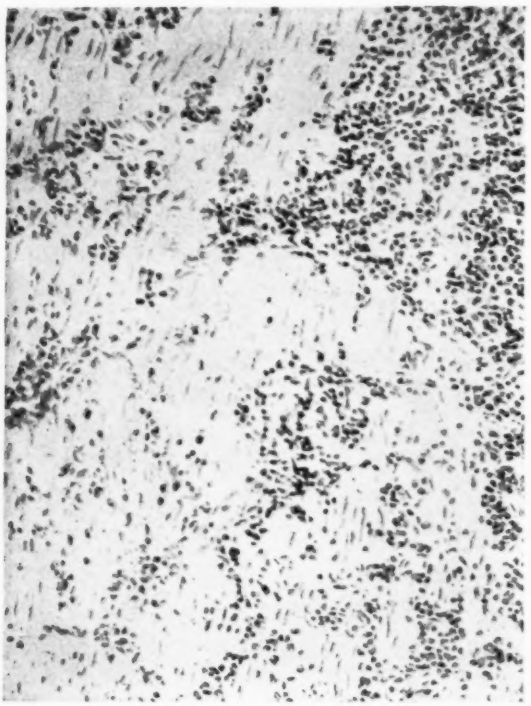

Fig. 6. Tumor in the muscular coat (low magnification).

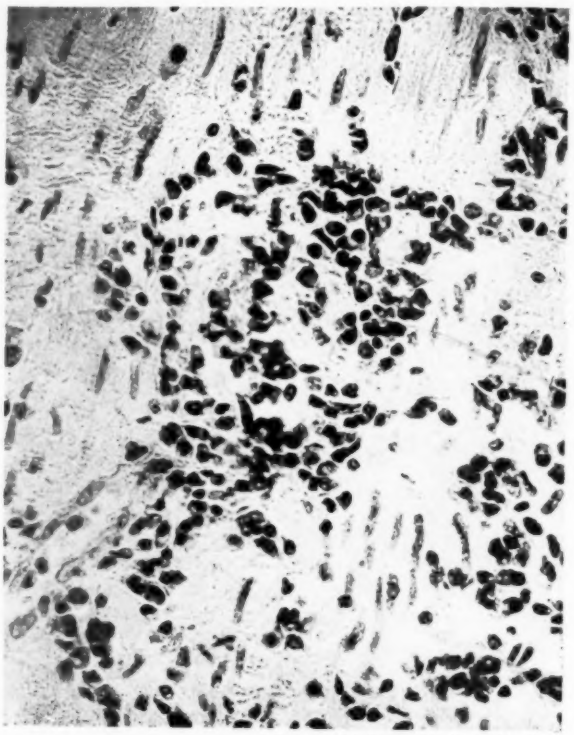

Fig. 7. Tumor in muscularis (high magnification).

Patient soon developed a large carbuncular abscess over the sacrum which, with a complication of bronchopneumonia as well as a low grade fibropurulent peritonitis, caused her death March 11, 1931.

The pathologic report on the specimen shown in Figures 4–7 is as follows: Lymphosarcoma or lymphoma of jejunum. Gross: The specimen consists of a portion of jejunum 16 cm. long, over an area covering about 8 cm. of the same, the wall is considerably thickened. The mucosa is soft, friable, and hemorrhagically discolored. The tissue beneath the mucosa is considerably hyperemic and edematous. The peritoneal surface of the entire specimen, cut particularly in the area described above, is hemorrhagically discolored and covered by a red stringy material.

Microscopic examination: Sections of jejunum show extensive invasion of the mucosa and submucosa and to a moderate extent the muscularis by a new growth of tumor cells which appear in large masses and replace the original tissue of the intestine. The main type of cell is round and resembles the lymphocyte. The nuclei are very chromatic, and mitotic figures are present. Some portions show vascular slits which are lined by the tumor cells. There are many areas of hemorrhage. The peritoneal surface shows considerable hemorrhage and is covered by a layer of fibrin in which are enmeshed endothelial cells, polymorphonuclear leucocytes and lymphocytes.

Reticulum stain revealed only few reticular tissue fibers extending in the tumor growth; but the fibers do not sufficiently surround the tumor cells as occurs in a reticulum-cell sarcoma.

Post-mortem examination was performed with the following significant findings: Metastasis of lymphosarcoma in the ovaries; fibrinopurulent peritonitis; bronchopneumonia in right lung; hypertrophy of heart; fatty degeneration of liver; acute splenic hyperplasia; acute hyperplasia of mesenteric lymph nodes.

CONCLUSIONS

Lymphosarcoma of the jejunum is an unusual finding, but in differentiating tumors of the jejunum it must be borne in mind. The most frequent tumor of the jejunum with which this growth might be confused is primary carcinoma. Secondly, the disease is usually fatal under the present treatment, namely surgery. Thirdly, I believe, in the future, the treatment of these cases involving the jejunum or any other portion of the gastrointestinal tract will be first, surgical exploration, then biopsy verifying the diagnosis, followed by intense *x*-ray radiation of the tumor as well as systematic raying of all the organs of the abdomen for possible metastasis. Combination of both *x*-ray and radium therapy, the radium in form of distance packs as well as contact radiation, have been known to give more or less permanent cures in lymphosarcoma cases.[8]

Fig. 8.

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ESSENTIAL SURGERY IN CHRONIC ULCERATIVE COLITIS*

CURTICE ROSSER, M.D., F.A.C.S.

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THE management of a widespread, disabling, often fatal disease, chronic ulcerative colitis, has been in the last ten years almost entirely relegated to the realm of medical treatment. Two factors conspired to bring this about. The mortality following operative interference in the past had been unusually high, due to the fact that surgeons did not understand the extreme permeability of a bowel carrying this infection and attempted to explore all cases, peritonitis frequently resulting from trauma, and to the fact that the preoperative and postoperative preparation was not properly emphasized. When the announcement was made that the disease was due to specific organisms and that vaccines and sera made from these organisms would cure the condition, the surgeon was glad to relinquish his attempts to combat the situation by radical means, and for ten years he has waited patiently to see the outcome of purely medical measures.

Four definite etiological agents have been postulated by different groups of observers, and each group seems equally convinced of the adequateness of their explanation and the complete efficacy of measures based on it. Because cases of amebic dysentery have been wrongly diagnosed as chronic ulcerative colitis one group has claimed that all cases are due to amebae. In England and Canada, and in some parts of this country, notably Baltimore, the theory of Hurst[1] and of Thorlakson[2] that the disease is related to bacillary dysentery has gained foothold, antidysentery serum being used. Larimore[3] in this country called attention to McCarrison[4] and Cramer's[5] observations on the injury to intestinal mucosa and atrophy of lymphoid tissue resulting from vitamin deficiency and postulated that chronic ulcerative colitis was primarily due to an avitaminosis. Unquestionably the most popular theory in this country is that first enunciated by Bargen[6] in 1924, that the disease is the result of infection of the colon with a specific streptococcus and that vaccines and later[7] sera from this organism are largely curative.

The burden of the present thesis is, briefly stated, as follows: Regardless of the final outcome of the discussion concerning the specificity of any etiological agent, and granting the value of recent discoveries, the results of treatment by present methods are nevertheless unsatisfactory. Surgical measures which have been in large part held in abeyance due to the high mortality formerly accompanying intervention and to present timidity in suggesting more radical measures in a condition urged to be purely "medical" have a wide field of usefulness which should be utilized. Such surgical procedures, which can be held to a lower mortality by proper application of new information concerning the pathology present will be useful in three ways: to cure the disease, to cure the patient if not the disease, to eradicate foci of infection in the zone of origin (the anal canal) as well as in distant foci.

Acceptation of this condition as one appropriate for medical measures only has resulted in a low hospital entrance rate, but a total of 38 cases diagnosed as chronic ulcerative colitis have entered Baylor Hospital (Dallas) during the past ten years. A survey of this group was made to bring out certain pertinent facts. Twenty-two patients were females, 16 were males.

* From the Section on Proctology, Baylor University Med. School, Dallas. Read before the Texas Surgical Society, Houston, November 17, 1931.

Two were under three years of age, the remainder were adults. Of this number 7 died in this hospital (18.4 per cent), practically one in every 5 cases. Of this 7 only one had any attempt to alleviate the condition surgically, and this was an improper procedure under an erroneous diagnosis of malignancy.

Practically all these cases were treated with vaccines, diet and irrigations, but 8 patients were treated surgically also. One was operated on for fistula with recovery of the colitis; one had a transverse colostomy for a long-standing left-sided infection, with complete recovery except for healed strictures; one ileostomy was done with recovery; 3 patients were operated on for infected hemorrhoids, 2 having anal ulcer, with improvement on discharge shown on the hospital chart.

One cecostomy was performed two months ago, with the result that a patient bedridden for eight months is now doing her own housework. With the exception of the one fatality already referred to, no patient who had any surgical procedure died or failed to improve, and of the 7 patients who did die of the condition, 6 were without the possible benefit of surgical interference.

In addition to those cases in whom the disease leads to a fatal termination, my own observations lead me to believe that there are thousands of these patients in this country returning to the doctor from time to time with new exacerbations of the disease or going from office to office or clinic to clinic with a constant chronic infection leading to impairment of health and invalidism.

The opinions of a group of surgeons most likely to see a volume of these cases have been recently sought to supplement the literature and these opinions will be quoted under two divisions: first those of the more conservative group who regard surgery as almost a last resort, second those who believe that operative measures should be much more frequently utilized than is now customary.

Under date of September 29, Dr. Fred Rankin wrote:[8]

Unquestionably, there is a certain time when one has to do a drainage operation for chronic ulcerative colitis. It should be in the intractable type of case which does not yield to any kind of treatment. Our experience with the acute, fulminating type has been very unsatisfactory; the mortality is very high and I question whether it is worth while doing it. I have never seen any advantage in doing a cecostomy or appendicostomy. We always do an ileostomy and I prefer to divide the bowel at the time. I think there is no question that we have had some very satisfactory results from ileostomy in the proper type of case at the proper time.

At the clinic ileostomy is used definitely in such complications as polyposis, strictures, extensive perirectal abscesses, etc. It is rarely used in the acute, progressively failing cases. In the past two years, ileostomy has been done in about three to four per cent of all cases of ulcerative colitis coming to the Clinic.

Under date of October 15, Dr. Jerome Lynch wrote:[9]

Answering your question, I believe there is a limited field for surgical procedure very seldom indicated in the acute cases, and then only following perforation, which has occurred in two instances in my experience.

In chronic cases where all other methods have failed, appendicostomy has given very satisfactory results, this operation I performed in the early days, 1914–1917; since then I have found surgery less frequently indicated.

In chronic cases where the infection has extended into the small bowel, ileostomy has given complete recovery. Roughly speaking about three per cent of the cases require surgical intervention.

In 1927, Fansler of Minneapolis wrote:[10]

Unless medical measures fail I do not believe that surgery is justifiable. During a remission there is no need of surgery and during an acute attack the operative mortality is high. The colon is highly infected, friable and should not be handled. Simple ileostomy with division well above the colon is the only procedure justifiable and even with this the operative mortality is about 50 per cent.

I find that a large group of experienced observers feel as I do that a condition so serious that it may and does bring about death or chronic invalidism, and prone to a variety of serious complications* should have the earlier benefit of surgical measures in addition to whatever else is done.

Lockhart Mummery and Sir Charles Gordon Watson, in a symposium on the subject in March, favored appendicostomy. Mummery said:[1]

My experience of the treatment of ulcerative colitis, which is fairly extensive, is that appendicostomy is curative, provided it is performed early, that is to say, before the bowel has been severely damaged. At St. Mark's Hospital we have large numbers of these cases and in the course of the last few years we have tried all the different treatments for the condition, but we have always come back to appendicostomy as the one method to be relied upon, not only to save the patient's life, but also to prevent frequent recurrences.

When patients are treated by medical men only, it often results in their being laid up in bed or undergoing treatment for many months in the year, and this in these busy days means that they are seriously handicapped. I have had to operate in many such cases and perform appendicostomy because the patients could not afford the time for the long and tedious treatments which were necessitated by the frequent recurrences. There is apparently no means of preventing recurrence, but if each recurrence is promptly and adequately treated, the tendency in time disappears.

If an appendicostomy is performed, the opening should not be closed until the patient has been for a full year without treatment and without any recurrence.

Gordon Watson said in the same symposium:[1]

Except in the mild cases, he (the speaker) always performs appendicostomy; he did not think one could deal with the proximal colon adequately by the rectum. He regarded appendicostomy as a definite life-saving measure in many cases.

Dr. Harvery Stone is quoted as saying in 1929:[11]

Treatment is in general unsatisfactory. Three classes of cases may require surgical measures: (1) the relatively mild group that fail to improve in spite of medical methods and result in chronic invalidism; (2) the persistently recurrent cases; and (3) the fulminant cases with great loss of weight, marked anemia, and asthenia. In these three types of the disease, operation should be performed before the general condition becomes critical and before systemic infection develops. In general, the operation of choice is ileostomy, but under special conditions other surgical procedures may be preferable.

Dr. Louis Hirschman of Detroit recently wrote:[12]

After seeing for many years cases of true ulcerative colitis which have persisted in spite of all forms of dietary, vaccine, medicinal and physiotherapy I have become convinced that surgery has a position of prime importance in the treatment of chronic ulcerative colitis.

In the acute fulminating type ileostomy is often a life-saving measure. It is far better to perform a cecostomy or ileostomy on a patient suffering from ulcerative colitis who might possibly have been materially improved by non-surgical measures than to wait too long. When a patient is emaciated, dehydrated and exsanguinated the operative risk is of course materially increased.

The majority of cases that come under my observation consult me only after a long period of non-surgical care, so fully 75 per cent of those under my care are advised to have surgical intervention.

Dr. Dan Jones of Boston, under date of October 15 wrote as follows:[13]

I am just as sure as I have always been that there is a field for surgical procedure in these cases. I believe that an ileostomy should be done in a few acute cases, perhaps rarely in a fulminating case, and always in a chronic case which is going steadily down hill in spite of any treatment. In acute cases it should be

* Bargen (*Arch. Int. Med.*, Oct. 1929) states that 268 complications occurred in 693 cases at the Mayo Clinic, including polyposis in 10 per cent, stricture in 8.5 per cent, arthritis in 4.33 per cent, perirectal abscess in 3.7 per cent, endocarditis, splenomegaly, renal insufficiency, each 1 per cent, perforation 2.6 per cent and malignancy 2.16 per cent.

done when there is much bleeding and many movements pulling the patient down faster than he can possibly stand. I do not regard appendicostomy or cecostomy as sufficiently helpful to be of value. It is difficult for a surgeon to estimate the percentage requiring surgery. Medical men will hold on to these cases so long that I believe I operate upon nearly 75 per cent of the cases I have been asked to see.

In 1928, Thorlakson of Canada stated:[14]

> The complications of ulcerative colitis are arthritis, haemorrhage, perianal abscess, stricture, polyposis, perforation and malignancy. As the nature of the microorganism responsible for the condition is not known, the treatment has not been standardized. The author has found a simple caecostomy for irrigation of great value. Transverse ileostomy is rarely necessary, but is of benefit in selected cases. Its indications are repeated profuse colonic haemorrhage, generalized polyposis, and a long-standing cases in which the colon has been converted into a useless fibrous tube.

It is apparent that there is a variance of opinion as to just what procedure should be done if surgical intervention is contemplated. My own judgment is that the mild but chronic case in which vaccines, sera, diet and rest fail to bring about remission promptly, or in those in which recurrence occurs, an appendicostomy or cecostomy is indicated. It seems reasonable to assume that this is the type of case which is not now submitted to surgical judgment, and it is possible that it is for this reason that some of the authorities quoted reply entirely on ileostomy.

In fulminating cases, where intervention is necessary to save life, or in any case complicated by polyposis, malignancy, hemorrhage, etc., a transverse ileostomy seems definitely desirable.

Observance of several tremendously important surgical principles, which have been brought out by the intensive study this condition has been given in recent years, should do much to keep the mortality within proper limits. The first is the use of one or more preliminary transfusions of blood, coupled with a smooth low residue diet and fluids by clysis. The second is complete avoidance of trauma to the colon in the laparotomy, best accomplished by the use of spinal anesthesia for relaxation, careful handling and no exploration. The third is prevention of soiling the wound until it has had opportunity to heal per primam, in other words the appendicostomy or cecostomy is best left closed for a period of five days to one week after the laparotomy.

The prevalence of recurrence in connection with chronic ulcerative colitis has enforced the suggestion that the etiologic organisms are retained between attacks in body foci. While the general opinion has favored these locations hallowed by custom, teeth, tonsils and sinuses, there are several significant facts which indicate that lesions in the anus itself may harbor the organism. The disease begins in the lower rectum always, each recurrence originates in the same area. Anal ulcer and cryptitis leading to perirectal abscess and fistula are not uncommon findings (see note) and are not sufficiently explained by the assumption that they are secondary to infection above.

I find that Dr. Hirschman agrees[12] that ulcerative colitis may be an ascending infection from anal foci.

It is suggested therefore that when the acute exacerbations are arrested, demonstrable infective pathology in the anus be surgically eradicated.

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[For Remainder of References see p. 394.]

ACUTE INTESTINAL OBSTRUCTION CAUSED BY IMPACTED GALLSTONES

WITH CASE REPORTS*

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INTESTINAL obstruction caused by the impaction of a large gallstone in the lumen is rather rare and warrants special interest, in that an early diagnosis and early operation will markedly decrease the mortality rate.

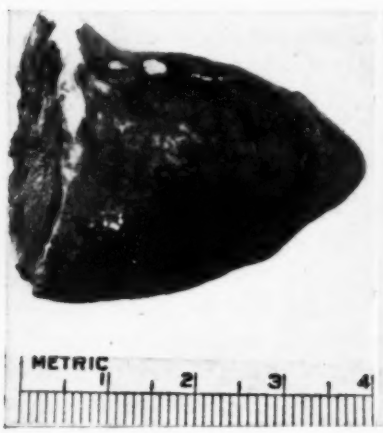

FIG. 1. Large, conical shaped stone from Case 11, measuring 5 cm. in length and 3 cm. at its base. Note pointed projection on superior border which caused perforation 49 inches distal to fistulous opening in gall bladder which is shown in Figure 3.

FIG. 2. Large single stone from Case 1, measuring 7 cm. in length and from 2.5 to 3.5 cm. in diameter, which completely occluded lumen of gut.

A review of the literature shows the first recorded case was that of Bartholin[1] in 1654. Later in 1890 Courvoisier[2] analyzed all reported cases prior to that date and found 131. In 1914 Wagner[3] made an exhaustive study of the literature and found 334 cases causing obstruction.

From the British Medical Association[4] a survey of 3064 cases of intestinal obstruction reported from seven hospitals in 1925, impacted gallstone was the cause in only 28 cases or less than 1 per cent, the most frequent being hernia, intussusception, malignancy, adhesions, volvulus and internal strangulation.

At St. Margaret's Hospital in a series of 172 cases operated upon for intestinal obstruction there were only 2 due to impacted gallstones. Powers[5] found 4 cases in 179 cases of intestinal obstruction. Moore[6] states from all available statistics that gallstones cause from 1 to 2 per cent of all intestinal obstruction. Martin[7] reports 1 case out of 280 cases of intestinal obstruction. So all statistics seem to be within a normal limit except the earlier views of Courvoisier, who gave a much higher estimate.

The recent literature includes only 3 cases which have been reported, one by Jackson and Ewell[8] and two by Siewerth.[9]

Gallstones entering the intestinal tract usually admit themselves by one of two methods: (1) by perforation from the gall bladder through the duodenal wall, of (2) by entering through the common duct. Our 2 cases chose the first route, by first producing a cholecystitis and cholelithiasis

* Read before the Kansas City Southwest Clinical Society, Kansas City, Kansas, Sept. 1, 1931.

followed by ulceration, erosion and pericholangitis. This was followed by the formation of adhesions between the gall bladder and neighboring viscera, and perforation occurring within these adhesions.

The duration of and the presence of symptoms seems to be questionable from recorded reports. Reimann and Bloom[10] reported a case following autopsy finding, the patient having died of empyema following lobar pneumonia. The postmortem examination presented a biliary fistula between the gall bladder and the pyloric portion of the stomach. A calculus about 2 cm. in diameter was found in a cystic cavity within the stomach wall. Though this patient was jaundiced there was no other history of gall-bladder disease. According to the history of both of our cases, they relate the presence of a sudden sharp pain in the region of the gall bladder, which was followed by continued nausea and vomiting. Previous to this attack they gave a history referable to gall-bladder disease. Neither of our patients was jaundiced due to the fact that the stone perforated through the wall of the gall bladder at the fundus into the duodenum at about the middle third.

The extent of passage down the intestinal tract is variable anywhere from the point of entrance to an exit at the rectum. Murphy[11] states that, of 125 cases, 70 after various and repeated colics, emesis, peritonitis, ileus, etc., were cured spontaneously by the passage of the stones per rectum. In such cases they may be single or multiple stones, usually of small caliber. Both of our cases were single, large stones.

In Case I the stone lodged 3½ feet from the adhesions of the gall bladder to the duodenum. In Case II the stone lodged 49 inches from the adhesions of the gall bladder to the duodenum. Once the diagnosis of obstruction due to impacted gallstones is made, immediate operation is imperative, and the duration as brief as possible. In the majority of cases a simple enterostomy is sufficient, and it is our belief that a cholecystectomy should not be considered until a later date. The best method of closing the enterostomy seems questionable. Brown[12] advocates recovering the stone through a transverse incision

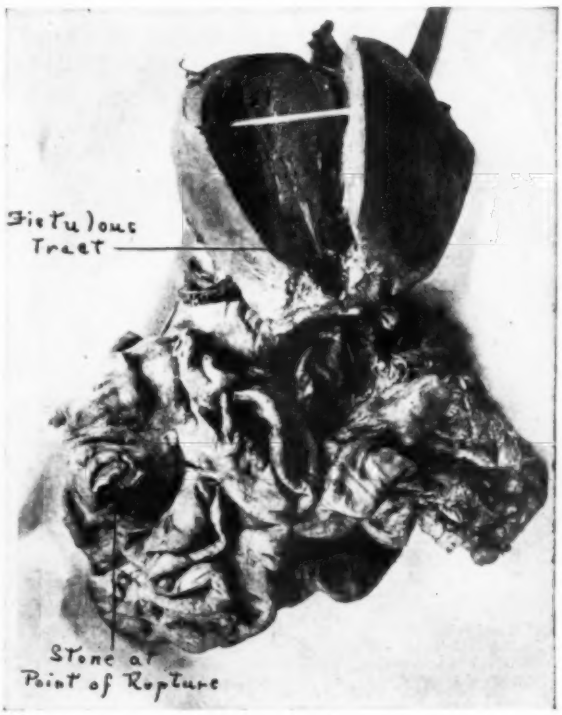

Fig. 3. Specimen en masse from Case II. Liver is sectioned, with probe passing through fistulous tract from gall bladder into duodenum. In lower left corner we see stone (Fig. 1) has ruptured through gut wall, presenting pointed projection.

in order to avoid such constriction of the intestinal lumen as occurs when a longitudinal incision is closed and inverted. Davis[13] advises a transverse closure of a longitudinal incision. In Case I we made a longitudinal closure of a longitudinal incision.

Case I. Mrs. L. D., white female, aged fifty-six, entered St. Margaret's Hospital on December 31, 1930 with a chief complaint of vomiting.

Present Illness: About one year ago patient had an attack of vomiting with pain in the right side along the costal margin. This pain was associated with much gas. During this sickness she was admitted to a diagnostic clinic, leaving much improved, with the diagnosis of gall-bladder disease. The patient enjoyed very good health until Christmas day, when following dinner she began to vomit.

She had no definite pain, but a generalized abdominal discomfort, and was unable to retain any food or liquid on entering the hospital. Patient denies a history of ever having been jaundiced. She has no substernal burning following vomiting. Bowel movements have been very irregular, being forced by enemas. She has voided only small amounts of urine. The patient has lost no weight in past three years. Her history is otherwise negative.

Physical examination reveals a large woman, weighing 155 pounds, good nutrition, skin very dry, no edema, no jaundice, and no general glandular enlargement, thyroid not enlarged, joints negative, extremities negative and examination of heart and lungs negative.

Daily reports on the patient are as follows: December 31, 1930: hypodermoclysis of 5 per cent glucose in 2000 c. c. of saline. Einhorn tube inserted with gastric lavage every two hours. Blood count: red blood cells 6,270,000; white blood cells 21,350; polymorphonuclears 83 per cent, hemoglobin 90 per cent. Blood chemistry: sugar 206, non-protein nitrogen 117.6, urea nitrogen 9.4, creatinine 3.2, carbon dioxide combining power 57.4, calcium 11.5 and phosphorus 4.2.

January 1, 1931: Urinalysis (catheter specimen): specific gravity 1.010, alkaline reaction, negative for albumin and sugar, few red blood cells and 3 plus white blood cells. Vomiting continued. Two thousand cubic centimeters of saline with 5 per cent glucose were given by hypodermoclysis. Acriflavine, grains ½ t. i. d.

January 2, 1931: 2000 c. c. of 2 per cent glucose given by hypodermoclysis; 2000 c. c. normal saline given by hypodermoclysis. Patient showed some improvement. Vomiting is decreasing.

January 3, 1931: 2000 c. c. of 2 per cent glucose given by hypodermoclysis; 2000 c. c. of saline given by hypodermoclysis. Blood chemistry: sugar 135, non-protein nitrogen 53.1, urea nitrogen 6.7, creatinine 1.1, carbon dioxide combining power 70, amino acids 6.2 mg.

January 5, 1931: Patient is some better. Feces examination shows some fat globules. Chemistry examination: amino acids 5.2 mg.

January 4, 1931: 4000 c. c. of normal saline given by hypodermoclysis. Patient's condition unchanged.

January 6, 1931: Patient is much better.

January 7, 1931: Liver function test five minutes 45 per cent, thirty minutes 5 per cent.

January 8, 1931: Urine is negative. Blood culture: no growth in four days. Patient is much better.

January 9, 1931: Patient is greatly improved.

January 11, 1931: Patient is much improved.

January 14, 1931: *X*-ray gall-bladder visualization with tetva iodide. Report is as follows: "The radiographs taken twelve and fourteen hours fail to show a shadow of the gall bladder. There is a peculiar rounded shadow occupying an abnormal axis for the gall bladder, but which suggests in its detail calcification of the wall of a large gall bladder. This shadow's identity is questionable."

January 15, 1931: Patient's condition excellent.

January 18, 1931: Patient is discharged.

Patient was readmitted to St. Margaret's Hospital on January 29, 1931, complaining of vomiting which began on the night of January 28 and continued throughout the night. The vomitus on admission to the hospital was bile stained. Two thousand cubic centimeters of normal saline were given by hypodermoclysis.

January 30, 1931: Urinalysis negative. Two thousand cubic centimeters of normal saline given by hypodermoclysis.

January 31, 1931: Patient is much better.

February 1, 1931: Patient is much better. Two thousand cubic centimeters of normal saline given by hypodermoclysis.

February 3, 1931: *X*-ray examination. Patient is seen without a preliminary meal, and is able to take only a small amount of opaque media. First bolus is projected into the duodenum, visualizing a large triangular duodenal bulb. In the semirecumbent position the media gravitates to the right of the spinal prominence and the upper jejunum fills rapidly. Definite dilatation of the upper jejunum is apparent and regurgitation is observed. The appearance of the jejunum does not suggest an absolute obstruction.

Plates: "Films of the abdomen show an incomplete obstruction of the jejunum on the left side of the abdomen."

February 4, 1931: 2000 c. c. of normal saline given by hypodermoclysis; 2000 c. c. of 5 per cent saline with 2 per cent glucose given by hypodermoclysis and two 50 c. c. ampules of 50 per cent glucose given intravenously. At no time through the stay in the hospital was visible peristalsis noted.

February 5, 1931: Patient was operated upon. A preoperative diagnosis was made of high intestinal obstruction due to impacted gallstone.

Operation was as follows: Under amytal, novocaine and ether anesthesia, a supra-umbilical midline incision was made. On opening the peritoneum a large amount of bile-tinged fluid was found, and a markedly dilated small intestine. The stomach and pancreas revealed nothing abnormal on examination. The small intestine which presented itself into the wound was distended and engorged. On tracing the distention there was found a collapsed portion about the distal portion of the jejunum and on palpation there was found to be a hard mass about the shape and size of a duck egg, completely obstructing the lumen of the gut. The gut distal to the mass was collapsed. Intestinal clamps were applied distal and proximal to the mass and a longitudinal incision about 5 cm. in length was made opposite the mesentery. The mass was easily delivered, and thereby exposed the intestinal mucosa, which from its condition showed that the stone has been in its present position sometime. But the condition (Fig. 2) of the gut did not warrant a resection. The incision was closed with catgut longitudinally. The gall bladder was not explored. The wound was closed in layers without drain and patient returned to her room in good condition.

February 6, 1931: 4000 c. c. saline was given by hypodermoclysis.

February 9, 1931: Patient's postoperative convalescence is excellent. Abdomen is soft and in excellent condition.

February 10, 1931: At 1:30 P.M. patient was awakened by a very sharp, severe pain in the lower abdomen. She was perspiring and looked as though she were in great pain. The abdomen was soft, no rigidity, but there was tenderness on firm pressure. The abdomen is tympanic, but no marked distention. At 2:00 P.M. the patient began having chills. Pain became more severe and abdominal rigidity was present. With a diagnosis of intestinal perforation the abdomen was reopened.

Operation: The original surgical wound was reopened. The coils of the jejunum presented themselves and were distended. No exudate was visible. On examination of the gall-bladder region and the under surface of the liver, a large amount of seropurulent fluid was present with an abundance of plastic exudate. The gall-bladder wall was injected and thickened, with many adhesions between it and the duodenum. A drain was placed under the liver and stab drain placed in the pelvis. The pelvic wound was closed, and the patient taken to her room in poor condition. Her condition grew rapidly worse and the patient died at 9:00 P.M. the same day.

Autopsy findings were as follows: (Only the organs of interest will be noted). The peritoneal cavity contained about 1500 c. c. of purulent fluid which contained abundant fibrin. Just below the surgical incision there is a part of the jejunum upon which an enterostomy has been performed. Three and one-half feet from the adhesions of the gall bladder to the duodenum there is an opening through which the intestinal contents have access to the peritoneal cavity. The gall bladder appears connected to the duodenum. The adhesions between the gall bladder and the duodenum upon dissection revealed a small fistulous tract present between the gall bladder and the duodenum, measuring about 5 mm. in diameter. The gall-bladder wall is markedly thickened. No stones are present.

Case II. Mrs. M. T. was admitted to St. Margaret's Hospital on March 31, 1931. She is a colored female, aged fifty-eight. Chief complaint is pain and vomiting.

Present illness dates back to about four weeks ago, when the patient had been having a dull pain in the epigastrium. One night while asleep she was suddenly awakened by a sharp pain in the epigastrium which was followed by vomiting, and continued until admission to the hospital. Patient has been unable to retain any food and only a small amount of liquids. Patient describes the vomitus as being of dark brown color and containing blood. The stools were tannish in color. She has lost an appreciable amount of weight in the past month. Due to the physical condition of the patient we were unable to obtain more history.

Physical examination revealed an extremely thin colored woman with an essentially negative examination, except for the abdomen which was full. No ascites. Pain was diffuse but most marked in the upper quadrant. No masses were felt. Liver and spleen were not palpable due to extreme tenderness.

Daily reports on the patient are as follows: March 31, 1931: Vomitus benzidine test

positive for blood. Red blood cells 4,500,000, hemoglobin 70 per cent, white blood cells 9150, polymorphonuclears 75 per cent. Urine was essentially negative. Three thousand cubic centimeters of saline was given by hypodermoclysis; 50 c. c. of 50 per cent glucose was given intravenously.

April 1, 1931: 3000 c. c. of saline was given by hypodermoclysis, 50 c. c. of 50 per cent glucose given daily.

April 2, 1931: Patient's condition does not improve and does not warrant an exploratory laparotomy.

April 4, 1931: Patient is growing weaker with increasing pain. She is cold and clammy and has slight distention.

April 5, 1931: Patient died at 3:00 A.M.

Autopsy findings were as follows: Upon opening the peritoneal cavity the peritoneum contained a large amount of fibropurulent exudate as well as some liquid fecal material. About 2000 c. c. of fluid are present in the peritoneal cavity, so that the surface of the peritoneum both in the lesser and greater peritoneal cavities is covered with a fibropurulent exudate, and numerous areas of hemorrhage are present, especially in the lesser peritoneal cavity over the pancreatic region. It is noted that the entire transverse colon is adherent to the gall bladder region. The liver over the gall bladder appears rather firm. The gall-bladder wall is markedly contracted and upon removal of the fluid from the peritoneal cavity there is seen a perforation in the small intestine (Fig. 3) about the lower portion of the jejunum which contains a large stone. The gastrointestinal tract shows a fistulous opening in the duodenum and a large stone, rather cone shaped, with the smooth portion pointing upwards. About the base the stone appears rather rough and irregular; the intestine around the stone has become necrotic and is ruptured. The stone presented itself about 49 inches distal to the fistulous opening of the gall bladder into the duodenum. At this point the wall is very thin and the erosion measures 2.5 by 1.5 cm.

COMMENTS

The presence of a gallstone or stones in the intestinal tract without the presence of symptoms is an established fact, in that they may lie dormant for a long period of time and never cause symptoms or death, or they may be passed by rectum without symptoms.

Our first case was obviously a case of intestinal obstruction, the perforation from the gall bladder into the duodenum occurring about one year before admission into the hospital. In Case II the entrance of the gallstone into the intestinal tract was four weeks before admission to the hospital. The perforation of the intestine, resulting in peritonitis, occurred at night during sleep and the day before entering the hospital. There was a fleeting obstruction for four weeks. There was no history of gall-bladder disease which aided in making the diagnosis of obstruction due to gallstones.

Acute intestinal obstruction caused by impacted gallstones is more infrequent than one would judge before reviewing the literature.

Regardless of the mode of entrance into the intestinal tract, the symptoms are essentially the same except the presence or absence of jaundice. The duration of time up to a partial or complete obstruction is a variable factor. In our first case the time was one year and the second was four months. Once the diagnosis is made an early operation is imperative, the extent of which varies according to the condition of the patient, and regardless of the severity of the condition of the patient, preoperative and postoperative administration of saline should be given subcutaneously and intravenously.

Case I was entered at St. Margaret's Hospital on the surgical service of Dr. C. C. Nesselrode and Case II on the surgical service of Dr. M. J. Owens.

LITERATURE

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2. Courvoisier. Cavistisch-Statistische Beitrage zur Pathologie und Chirurgie der Gallenwege. Leipzig, 1890.
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[For Remainder of Literature see p. 412.]

TRANSVERSE INCISION IN 100 CONSECUTIVE APPENDECTOMIES*

REGINALD A. CUTTING, M.D., M.A., PH.D.

NEW ORLEANS

IT would almost seem as if any discussion of appendicitis and appendectomy undertaken *anno Domini* 1931 should be prefaced by an apology for again dragging to the fore a subject already so thoroughly examined that its garments seem threadbare and devoid of ability further to conceal any clinical secrets at all. This would seem especially so in view of the fact that the present discussion purports to contribute nothing essentially new, but only to present a new series of cases and to direct attention to certain considerations of technical and clinical significance which are new only in their arrangement and method of presentation. The fact remains, however, that of all the major procedures in surgery there is none which is more frequently performed by immature and unskillful hands than the operation of appendectomy and for this reason, if for no other, the repetition would seem justifiable.

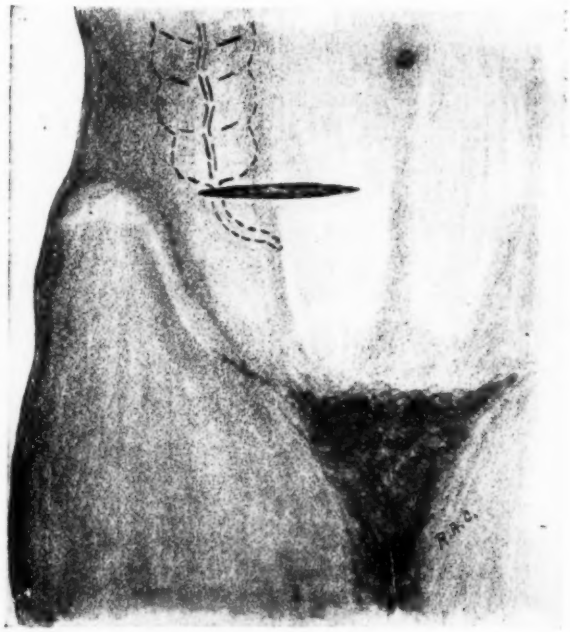

FIG. 1.

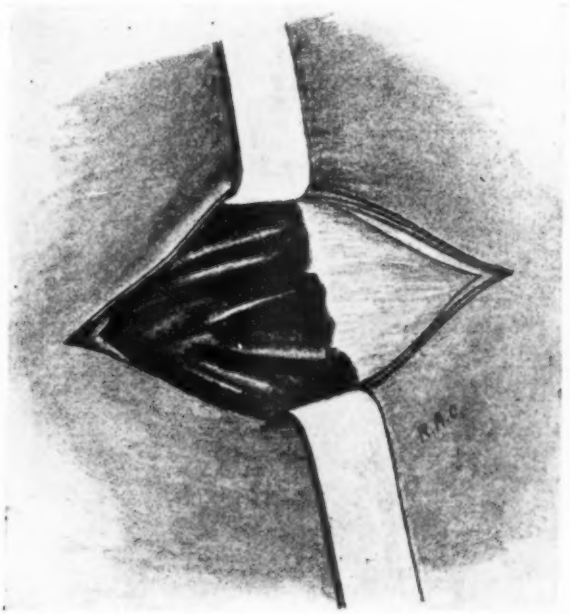

FIG. 2.

For a number of years, I have been convinced that the transverse incision as described by Davis[1] in 1906, frequently called the "Davis incision" is the most rational abdominal incision for use in performing simple appendectomy.[2] Naturally for exploratory laparotomies in which the preoperative diagnosis is very much in doubt, or in which there is reason for believing that more extensive procedures than appendectomy will be required, a "median," "paramedian," or some other incision is usually preferable, but, on

[1] Davis, C. G. A transverse incision for the removal of the appendix. *Ann. Surg.*, 43: 106, 1906.

[2] This incision is said by Davis to be a modification of an incision described by J. W. Elliot (*Boston M. & S. J.*, 2: 433, 1896).

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the other hand, the transverse incision does not so limit the field of operative attack as to prevent dealing on occasion with abnormalities which simulate, clinically, the picture of acute appendicitis: Meckel's diverticulitis, tumors of the cecum and terminal portion of the ileum, tumors of the ovary, fallopian tube and uterus, low mechanical ileus, extra-uterine pregnancy and the like.

In view of the fact that the incision under discussion is perhaps not familiar to many persons who otherwise might use it and eventually come to regard it in the same high esteem as I do, I have decided to review the technical steps in its performance and also to present a clinical survey of the operative, convalescent and subsequent histories of the last 100 consecutive cases in which I have used the incision. All the cases were operated upon from the services of Dr. Alton Ochsner and Dr. I. M. Gage in the Charity Hospital of New Orleans, and I am indebted to the Superintendent and Officers of the institution for permission to make use of the hospital records of the cases in preparing this survey.

TRANSVERSE APPENDECTOMY INCISION

When properly performed, the transverse appendectomy incision about to be described presents the following noteworthy advantages: 1. The skin incision closely conforms to the natural skin cleavage lines of the anterior abdominal wall. This consideration is important in that the natural tendency of the finished skin wound is not to gape but rather to remain closed, and furthermore, when fully healed to be only slightly visible provided accurate apposition of wound edges has been primarily secured and subsequently maintained. 2. The division of the deeper structures is made in accordance with approved anatomical principles—in other words, there is no division of muscle fibers, aponeuroses are split rather than cut, and the completed abdominal incision tends to be drawn together by the natural stresses exerted by the elasticity and muscular pull of its component parts; these parts also imbricate themselves in such a manner as to insure additional strength. 3. It is correctly placed with reference to the surface anatomy of the appendix; the opening in the abdominal wall is directly over the base of the appendix and cecum, and, therefore, the margins of the wound do not have to be retracted this way or that in order to expose the structures to be manipulated; this is true to the same extent of no other appendectomy incision. 4. When ordinary care is used there is no danger of wounding important structures and thus interfering with the subsequent integrity of the anterior abdominal wall; the incision, being transverse, parallels the general direction of the intercostal nerves, which supply the intrinsic musculature of the anterior abdominal wall, and the epigastric vessels, which are the only blood vessels of any size in the general region, are well beyond the medial end of the incision. 5. The incision is of ample size, when made as suggested, to permit moderately extensive exploratory examinations, especially exploratory examinations of the uterus and adnexa, and can be conveniently enlarged when necessary to take care of unusual and unexpected abnormalities; the primary usefulness of the incision is not, however, as an exploratory one.

It is of the utmost importance that the incision be placed properly, both as to its direction and also as to its level. The proper level is that of the anterior superior spine of the ilium. The proper direction is exactly transverse, that is, strictly at right angles to the long axis of the body, and the incision is so planned that its middle corresponds as nearly as possible with the right linea semilunaris, that is, with the outer border of the right rectus abdominis muscle (Fig. 1). When about to make the incision it is my custom to locate the anterior superior spine of the ilium accurately with the thumb of the left hand and place the tip of the index,

or, better perhaps, the middle finger of the same hand, in the region of the median line of the body and strictly on the same level as the thumb. The imaginary line connecting the tip of the thumb with the tip of the finger represents the line of the incision. By spreading the thumb and finger slightly the proper degree of tension can be exerted on the skin to make it sufficiently taut to be properly cut with the knife. The knife is grasped in the right hand, and an incision of the desired length is made with a single sweep of the scalpel. The length of the incision may, of course, vary in accordance with the preferences of the individual operator, and also with the estimated thickness of the anterior abdominal wall, because when the anterior abdominal wall is thick a longer incision is ordinarily required than when the abdominal wall is thin. Because I dislike working in cramped quarters and also because I believe that an adequate incision is to the patient's distinct benefit, it is my custom to make the incision at least 3 inches in length in all cases. The incision is carried directly to the underlying aponeurotic plane which consists of the fibers of the external oblique aponeurosis. This aponeurosis is cut transversely in the same direction as the original skin incision and somewhat obliquely to the course of the fibers of which it is composed. By this maneuver is exposed the deeper aponeurotic plane which consists of the anterior sheath of the rectus muscle in the medial one-half of the wound and the aponeurosis of the internal oblique muscle in the lateral half (Fig. 2). As previously stated, in the middle of the incision is the linea semilunaris. It will be noted when this incision is used in a series of cases that the width of the rectus muscle varies considerably from patient to patient, and although one should, when possible, plan the incision so as to be accurately bisected by the linea semilunaris, one may be surprised to find on actually exposing the linea similunaris in any given case that it lies in a somewhat different right or left position from that which was originally expected. It should also be noted that the fibers of the internal oblique muscle are largely aponeurotic as they lie in the depths of the incision, except in the extreme lateral angle of the wound. The proportion between the muscular segment of the internal oblique muscle and its aponeurotic

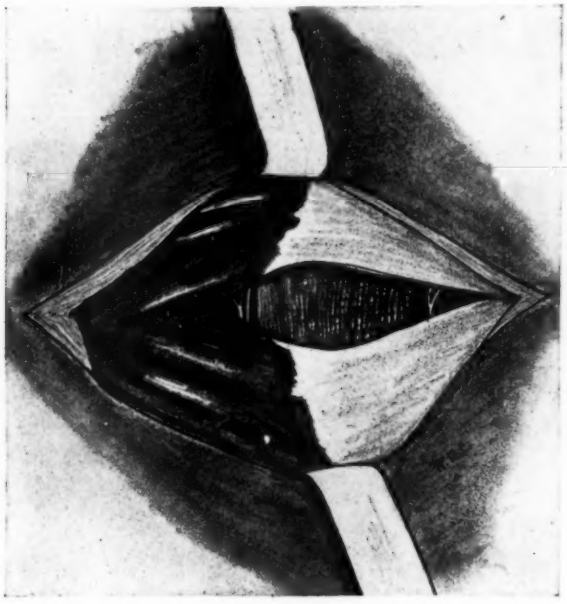

Fig. 3.

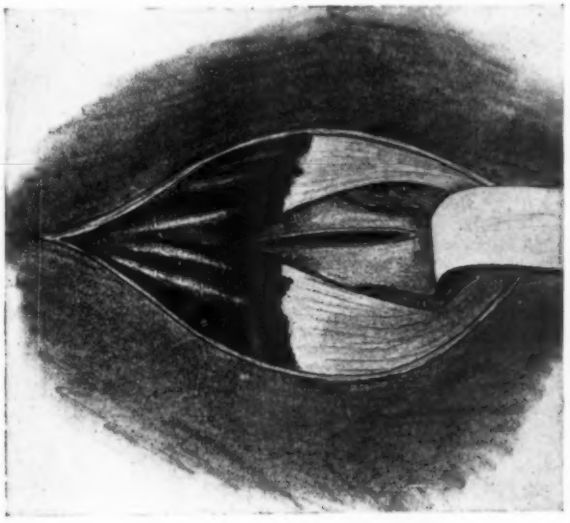

Fig. 4.

portion varies in different individuals, and not infrequently the entire expanse of internal oblique which is exposed in the

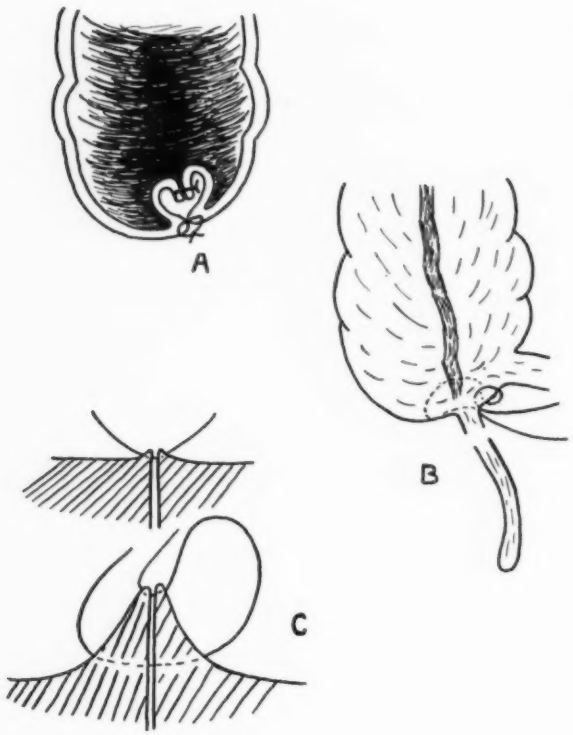

Fig. 5.

incision is found to be aponeurotic and not muscular.

The amount of hemorrhage which is encountered during the initial incision varies, of course, from patient to patient and is controlled by the prompt use of hemostat and ligature; there are no blood vessels of considerable size or constant location in the field. The next step in the procedure, however, consists in incising the anterior sheath of the rectus exactly transversely; i.e., in the same direction as the original skin incision, and in this portion of the incision there are two minor blood vessels which are of rather constant location. Toward the medial angle just beneath the anterior sheath of the rectus muscle there usually occurs a small vessel which is a branch of the deep epigastric artery and which courses in the long axis of the body, parallel with the fibers of the rectus abdominis muscles and perpendicular to the line of incision. Just within the linea semilunaris and coursing also just beneath the anterior sheath of the rectus muscle there occurs rather constantly another small vessel which is also a branch of the deep epigastric artery, the course of which is also perpendicular to the line of incision (Fig. 3). Frequently both of these vessels are of about the same size, although occasionally one is much larger than the other, and occasionally either the one or the other seems to be absent. If the location of these two small vessels be borne in mind while incising the anterior sheath of the rectus muscle the severed ends of the vessels can be immediately caught with hemostats and the technical excellence of the operative procedure can thereby be improved. These vessels are not really larger than the vessels commonly severed during the performance of any other operative procedure but are so constant in location as to deserve a word of mention.

After the anterior sheath of the rectus muscle has been incised as far as the linea semilunaris the blunt points of a Mayo scissors are introduced into the tissues just at the lateral border of the rectus muscle and are slightly separated in order to uncover the line of cleavage between the posterior surface of the rectus muscle and the transversalis fascia. As soon as this line of cleavage has been recognized, the finger of the gloved hand is introduced posterior to the belly of the rectus muscle and insinuated beneath the muscle towards the midline, sweeping the finger slightly backward and forward to free the muscle of its friable posterior attachment. As soon as this manipulation has been performed a Parker, or "ribbon," retractor is hooked over the lateral edge of the muscle and the muscle belly is gently retracted medially so as to expose a triangular shaped area of the transversalis fascia (Fig. 4). If the incision has been performed at the proper level there

is no posterior rectus sheath at this point, although occasionally if the incision has been made a little too high and medial retraction of the rectus muscle is performed rather vigorously in cases in which the attachments of that muscle to its sheath are not too firm, the fold of Douglas, or linea semicircularis, which represents the most caudad portion of the posterior rectus sheath may be seen in the upper portion of the wound.

The transversalis fascia and peritoneum now tend to pouch into the wound. Sometimes the transversalis fascia is thick and fibrous, sometimes veil-like and friable in this locality. In case transversalis fascia and peritoneum are thin, coils of intestine may be plainly seen outlined beneath them. Ordinarily the deep epigastric vessels are not seen because they are too near the midline at the level at which the incision is made; however, if the incision is inadvertently made too low or if, on the other hand, the vessels course a little more laterally than usual the epigastric vessels may be seen in the medial angle of the incision. At all events they should be looked for lest they be inadvertently incised during the next procedure.

The next process consists in opening the abdominal cavity. The incision is started through the pouching transversalis fascia and peritoneum with the precautions commonly used when opening into the peritoneal cavity; i.e., picking up the layer consisting of transversalis fascia and peritoneum between two pairs of tissue forceps, alternately releasing and applying first one and then the other of these forceps in such a way as to allow any fragments of omentum or bowel which may have been picked up by chance to disengage themselves and fall away from the lower surface of the parietal peritoneum, then carefully nicking the membrane with a knife, inserting a finger into the nick thus made, and extending the incision by cutting with a knife along the finger as a guide. The incision is made strictly transversely as were both of the previous incisions; viz., the incision through the skin and through the anterior sheath of the rectus muscle. Occasionally the rectus sheath is so wide that this maneuver gives ample exposure; usually, however, such is not the case, and the incision is next carried laterally directly through the linea semilunaris. As soon as the linea semilunaris has been cut the natural course of the aponeurotic fibers of the internal oblique and transversus muscles is respected. The incision is enlarged from this point outward by blunt dissection with the handle of the knife, the blade only being used to divide the transversalis fascia and peritoneum.

In most cases the structure which presents in the wound after this manipulation has been performed is either the omentum or the cecum. If omentum presents in the incision, however, it does so merely because it overlies the cecum, and the cecum may be exposed by displacing the omentum toward the midline. The cecum is readily recognized, of course, by the presence of its tinae coli, but even before the tinae are seen the cecum is usually recognizable both by its sacculated appearance, by its size, and also by the fact that it is whiter in color than any loops of small intestine which may appear beside it. The cecum is now grasped between the thumb and index finger and is pulled upward, outward, and cephalad. If the cecum is mobile, the caput ceci is displaced by this motion so that it lies directly in the abdominal incision, and if the appendix is not anchored to other structures by a congenital band of fibrous tissue or acquired adhesions it is rendered immediately visible. If this manipulation, however, does not succeed in bringing the appendix directly into the wound the base of the appendix can be located without further ado by tracing one of the tinae coli toward the pelvis. The point at which this landmark is lost accurately represents the base of the appendix, except in those rare cases in

which the area is overlain or distorted by abnormally placed tissues.

No mention need here be made of the various methods of dealing with anatomical variations in the position or environs of the appendix, because such methods as are suitable for dealing with these anomalies when any other incision is used are equally effectual with this one. A word, however, may be said with regard to the rational manner of dealing with the stump of the appendix after the appendix proper has been removed. I cannot believe that any technique of treating the stump of the appendix is rational if it does not include some sort of inversion. I am aware that many surgeons do not agree and habitually practice simple ligation of the stump, returning the cecum forthwith to the abdominal cavity. Although I am not prepared to contend that such a procedure is particularly dangerous or that patients subjected to such a procedure are particularly likely to develop serious disabilities therefrom, I cannot help feeling that there is a distinct danger in returning the contaminated mucosa which occurs between the ligature on the stump of the appendix and the severed end of the stump into the free peritoneal cavity, and this even though pains be taken to treat this mucosa either with a chemical antiseptic or with heat. I furthermore believe that the procedure which involves preliminary ligation of the stump of the appendix and subsequent inversion of this ligated stump through a purse-string suture in the wall of the cecum is also not in accordance with the best surgical principles, for it involves burying a contaminated area in such a way that no outlet is provided for any secretion which may form during the process of sloughing and absorption of the strangulated tissues distal to the ligature used on the stump (Fig. 5A). I have observed that in a certain number of patients in whom the technique under discussion has been used, the postoperative condition of the patient presented a rather typical sequence. For the first twelve, eighteen, or twenty-four hours the postoperative convalescence is no more eventful than it should be, but at the end of this period the pulse becomes somewhat more rapid, the temperature rises, sometimes only a degree or two, sometimes to 103° or even 103.5°F. The patient usually looks sick, may complain of moderate nausea, develops some abdominal pain which is usually interpreted as "gas pains," and the general condition of the patient may be so unsatisfactory as to cause the medical attendant some anxiety with respect to the cause of the condition. More or less abruptly, however, at the end of about fifty-six or seventy-two hours the patient exhibits a rather abrupt change for the better, the pulse rate decreases, the temperature diminishes, the abdominal pain ceases, and from that time on the patient makes an uneventful recovery. The obvious interpretation of this phenomenon is that septic material has been imprisoned in the wall of the cecum, has undergone a marked increase of virulence with the production of a small abscess, the abscess increasing in size until eventually the suture originally tied at the base of the appendix undergoes solution and the abscess breaks spontaneously into the cecum.

The rational method of treating the stump would then appear to be a procedure which involves inversion of the stump in the absence of preliminary ligation. The objection to such a procedure consists, of course, in the fact that usually or, at least, not infrequently a small intramural vessel occurs in the wall of the stump of the appendix which if not ligated is apt to cause a reactionary hemorrhage into the cecum. Such a circumstance can, however, be readily obviated by the simple expedient of encircling the area in which this vessel occurs with a suture. Such a suture can be conveniently placed concomitantly with the introduction of the purse-string suture by the insertion of a simple back-stitch in the location

of the mesenteric attachment of the appendiceal stump (Fig. 5B). The recommended procedure is, therefore, preliminary insertion of a purse-string suture with a back-stitch in the position previously mentioned, crushing of the base of the appendix with a strong Ochsner clamp, severence of the appendix, preferably with the actual cautery, and inversion of the crushed stump of the appendix through the purse-string suture without preliminary ligation.

In extremely difficult cases it is occasionally desirable to extend the incision in order to provide a wider exposure. This can readily be accomplished by dividing the tissues laterally, respecting the general direction of the fibers of the internal oblique and transversus abdominis muscles and carrying the incision as far as may seem necessary above the anterior spine of the ilium toward the right flank. Such an extension of the incision is rarely necessary but the amount of additional exposure which can be gained thereby is considerable and this consideration provides assurance that unusual abnormalities can almost invariably be met with confidence.

Closure of the abdominal incision is performed in four layers. The first layer includes the peritoneum and transversalis fascia. It is my custom to begin the suture at the medial angle of the wound and to sew progressively toward the lateral angle. When introducing the first stitch at the medial angle of the wound, it is important to bear in mind the anatomical position of the deep epigastric vessels in order that these may not be inadvertently damaged by the passage of the needle. In most cases the transversalis fascia in this area constitutes a rather definite layer. I am convinced that the cause of many postoperative herniations is failure to identify and accurately to suture the transversalis fascia, and accordingly during the insertion of the first line of sutures this structure is diligently sought and carefully sutured.

The transversalis fascia is, of course, quite different from the transversus abdominis muscle although the two structures are in close physical juxtaposition and are, in fact, not infrequently confused in the minds of those whose knowledge of anatomy has not been refreshed by specific reference to the matter. The transversalis fascia is a definite sheet of fascia which is spread over, but attached only loosely to the deep surface of the transversus muscle. Occasionally this structure is rather thin and indefinite, especially in certain portions of its extent; in other cases and in other portions it is an exceedingly tough and fibrous membrane which is capable of withstanding a very considerable portion of the total intra-abdominal pressure. The attachments of this structure are: *superiorly*, the fascia which covers the lower surface of the diaphragm; *posteriorly*, it becomes thinner and thinner and eventually becomes lost in the fat which covers the posterior aspect of the kidneys; *inferiorly*, from before backward it is attached (1) to the entire length of the iliac crest between the attachments of the transversus and iliacus muscles, (2) to the posterior margin of the inguinal ligament, at which point it becomes continuous with the iliac fascia, and (3) to the pubis and pectineal line; *medially*, it blends with its corresponding portion on the opposite side. Because of its usual firmness and density this structure ordinarily accounts for a very considerable part of the entire tensile strength of the anterior abdominal wall.

As soon as the first layer of sutures has been placed the rectus muscle is allowed to assume its natural position overlapping the medial half of the incision, and attention is directed to the placing of the fascial layer sutures. In placing these sutures it is my custom to begin at the medial angle of the incision and to sew toward the lateral angle. On reaching the linea semilunaris care is taken to place one stitch accurately in the linea semilunaris, and beyond this stitch the

edges of both internal oblique and transversus abdominis muscles are picked up together in the bite of the needle. The third layer closes the external oblique aponeurosis. The fourth layer of sutures closes the skin.

For some time it has been my practice to close the skin by means of interrupted sutures. I generally use paraffinized silk for this purpose, and the suture which I prefer is one which is designed to obliterate the subcutaneous dead space formed by retraction of the subcutaneous fat. If this dead space be not obliterated by one means or another, serum and blood tend to accumulate just beneath the skin, and there results a pool of liquid material or coagulated blood which does not undergo prompt absorption. The presence of such a collection of tissue fluid may be recognized by the alert surgeon who suspects its presence because of a rise in temperature and pulse rate of the patient and tenderness over the incision, and it may then be evacuated, usually after the removal of one or more stitches, or the condition goes on unrecognized until the stitches are removed after the lapse of a certain number of days at which time the margins of the wound separate, the material is extruded, and the skin incision must thereafter heal by secondary intention. This material may undergo secondary infection in which case a subcutaneous or stitch abscess forms. When introducing the suture under discussion, the purpose of which is to obliterate the dead space and accordingly to prevent the development of this complication in the wound, it is my custom to pass the suture by means of a straight Keith needle, introducing the needle when passing across the wound for the first time as near the skin edge as possible, thereafter lifting the tissues of the anterior abdominal wall perpendicularly, using the suture as a tractor, and passing the needle back through the tissues at a much deeper level (Fig. 5C).

When the transverse incision is properly made it is, I believe, the most rational and satisfactory incision which can be used in the procedure of simple appendectomy. It is essentially a muscle-splitting, or rather a fascia-splitting, incision and in this respect somewhat resembles the McBurney incision. It possesses, however, the following very important advantages over the McBurney incision: (1) It definitely avoids injury to the ilio-inguinal and iliohypogastric nerves which emerge just medial to the anterior superior spine of the ilium. These nerves can fairly easily be injured during the dissection incident to a McBurney muscle splitting incision, especially if the incision is made too near the anterior superior spine of the ilium. They could be injured in a transverse incision only in case the operator extends the incision too far laterally and forgets the location of these important structures. (2) The transverse incision gives much better exposure than the gridiron incision length for length. (3) The exposure being better in the transverse incision, the transversalis fascia is more readily located and sutured during closure. (4) Postoperative hernias do not seem to occur with any degree of frequency in connection with the transverse incision, but for some reason not altogether clear are frequent in connection with the gridiron incision.

STATISTICAL SURVEY OF CLINICAL DATA

As stated in the title of this communication, the statistical survey of cases is based upon 100 consecutive appendectomies. These were performed by the technique already described, between February, 1928 and June, 1931.

The first portion of the survey concerns itself with the more important clinical facts which were established during the course of the patient's actual residence in the hospital and include: (1) the age incidence of the disease "chronic appendicitis" as it has been my privilege to observe it in a ward for white female patients; (2) the clinical manifestations of the disease both with respect to duration

of symptoms at the time the patient came under observation and the identity and general distribution of those symptoms among the group of cases; (3) the laboratory data obtained from the cases, especially the details of the urinalysis and blood picture; (4) the serological (Wassermann) reaction with respect to syphilis; (5) the operative findings as gleaned from the notes dictated immediately after the operation to the operating-room staff secretary of the hospital; (6) the nurses' record of the temperature of the patients on the day preceding operation and for five consecutive days thereafter, and (7) my own, the interne's, or some other member of the staff's note at the time of the removal of sutures as to the condition of the operative incision at that time.

The second portion of the survey concerns itself with data obtained partly from a questionnaire sent to patients some time after their dismissal from the hospital and partly from personal observation of patients who on request but voluntarily presented themselves to me for examination of end results.

Age Incidence: The ages of the patients ranged between twelve and forty years, the average age for the entire group being 17.9 years. The distribution was as follows:

Between 12 and 15 years	28 per cent
Between 16 and 20 years	56 per cent
Between 21 and 25 years	11 per cent
Over 25 years	5 per cent

Duration of Symptoms: The duration of symptoms at the time of application of the patient to the hospital for treatment ranged from three days to eight years, the average duration was 16.5 months. The distribution was as follows:

Less than 1 month	8 per cent
Between 1 month and 3 months	16 per cent
Between 4 months and 12 months	41 per cent
Between 1 year and 2 years	17 per cent
More than 2 years	18 per cent

"Attacks of Appendicitis": Seventy-one per cent of the patients had experienced one or more definite "attacks of appendicitis"; in the remaining 29 per cent the complaints were of a more insidious onset without acute exacerbations.

Time Interval since Last Attack: In the case of those patients who gave a history of attacks, the average time interval which had elapsed between the onset of the last attack and the date of the operation was 17.3 days; the shortest interval of time was three days and the longest was eighty-five days. These figures are of no particular interest except as they serve to emphasize the fact that the type of appendicitis under discussion is not the acute or subacute variety but so-called "chronic appendicitis."

Symptoms: *Pain:* All patients complained of pain. The site of the pain was located in most of the cases in the right lower quadrant of the abdomen. In more than half such cases the pain was said to show no radiation. When the pain showed radiation the most frequent direction was toward the right thigh and leg. In the remaining cases the radiation was either through to the back or both to the back and to the right thigh.

Site of the pain in the right lower quadrant of the abdomen	83 per cent
No radiation of the pain	56 per cent
Radiation of the pain to right thigh or right thigh and leg	21 per cent
Radiation to right side of the back and region of the right kidney	4 per cent
Radiation both to the back and to the right thigh	2 per cent
Total	83 per cent

Site and radiation of pain in the remaining cases was as follows:

Region of the umbilicus radiating to the right lower quadrant of the abdomen	10 per cent
Both lower quadrants of the abdomen without radiation	5 per cent
General abdominal pain	2 per cent
Total	17 per cent

Nausea: Nausea was a feature of the disease in considerably more than half the cases. In only a small percentage, however, was it severe.

Severe nausea	10 per cent
Moderate nausea	51 per cent
No nausea	39 per cent

Vomiting: Vomiting was a feature of the disease in slightly more than one-third of the cases, but severe or repeated vomiting was only occasionally reported.

Severe or repeated vomiting	8 per cent
Occasional vomiting	27 per cent
No vomiting	65 per cent

Constipation: Constipation was far from the rule, and severe constipation was a relatively rare symptom.

Severe constipation	5 per cent
Moderate constipation	13 per cent
No constipation	81 per cent
(Alternating constipation and diarrhea—1 per cent)	

Other Symptoms: Because of the fact that the data from which these statistics were compiled consisted of routine hospital histories it would be misleading to attempt any exact statistical record of minor symptoms inasmuch as undoubtedly specific questions with regard to the entire list of minor symptoms were not attempted in recording the anamnesis. It is interesting to note, however, that (1) stiffness of the right thigh and (2) headache were each mentioned as prominent symptoms in more than 10 per cent of the cases. Dizziness, weakness, distention and belching, fainting, frequency of urination and burning on urination, weakness and loss of weight, and anorexia were prominent symptoms each in more than one case.

Temperature on Admission to Hospital: The mean temperature *per os* of the group on admission to the hospital was 98.5°F.

Leucocyte Count: The mean leucocyte count is recorded in the following tabular form:

Total Leucocytes	Polymorphonuclear Leucocytes, Per Cent	Large Mononuclear Leucocytes, Per Cent	Lymphocytes, Per Cent
5325	71.02	3.11	24.7

Only 19 of the cases presented a total leucocyte count of 10,000 or more. A more detailed resume is as follows:

Less than 6000 leucocytes	3 per cent
Between 6000 leucocytes and 7000 leucocytes	20 per cent
Between 7000 leucocytes and 8000 leucocytes	14 per cent
Between 8000 leucocytes and 9000 leucocytes	30 per cent
Between 9000 leucocytes and 10,000 leucocytes	14 per cent

Urine: The routine urinalysis showed no positive findings worthy of note in 40 per cent of the cases. In the remaining cases the findings were reported as follows:

Occasional pus and epithelial cells	25 per cent
Occasional pus cells	15 per cent
Occasional epithelial cells	6 per cent

The remaining 14 cases presented:

Many pus cells	2 cases
Many pus and epithelial cells, occasional casts	2 cases
Occasional pus cells and hyaline casts	2 cases
Occasional red cells	2 cases
Many epithelial cells	2 cases
Occasional pus cells, many bacteria	1 case
Occasional cylindroids, few pus cells	1 case
Albumen and casts	1 case
Trace of sugar	1 case

No examinations were made for acetoacetic acid and acetone or for indican.

Wassermann Reaction: The Wassermann reaction was negative in all cases in the series.

Anesthesia: Various anesthetic agents were used in performing the operations on the patients in the group, as follows:

Avertin (basal anesthesia)	27 cases
Local anesthesia (procaine)	2 cases
Ethylene	2 cases
Nitrous oxide	2 cases
Sacral analgesia	1 case
Ether	66 cases

In 4 of the 27 cases in which avertin basal anesthesia was used this anesthetic did not need reinforcement, and the operation was accordingly performed under avertin anesthesia alone. In the remaining 23 cases the avertin was reinforced with a small amount of ether, usually less than 1½ ounces of the latter being sufficient. Undoubtedly ether might not have been

required in certain of the cases in which it was actually used, but it became apparent after some experience with avertin had been gained that in the dose used (100 mg. per kilogram of body weight) some of the patients would tolerate the making of the initial incision without any reaction of any kind, but became unruly when hemostats began to be applied. This was disconcerting because manipulations then had to be suspended until a small amount of ether could be given; accordingly, it soon became routine practice to give a small amount of ether before the incision was made whether it seemed likely that the basal anesthetic would suffice or not.

Local anesthesia was adopted in 2 cases because of respiratory tract infection of patients.

Sacral analgesia was adopted in 1 case as a demonstration that extradural anesthesia can be used on occasion for the performance of abdominal operations. It is not believed, however, that such anesthesia is either desirable or entirely safe for such purposes; I do not make a practice of resorting to this method, and I do not recommend that others do so.

In avertin, on the other hand, I believe has been found an almost ideal form of basal anesthesia, and I feel that the extra time taken in giving this form of anesthesia pays rather rich dividends both in comfort to the patient and in satisfaction to the surgeon, especially as concerns the early postoperative period.

It will be noted that spinal anesthesia was not used at all in this series of cases. Although I fully appreciate the advantages of spinal anesthesia as far as the operator is concerned and the advantages to the patient in the vast majority of cases, especially as concerns the early postoperative period, I am not quite convinced that the margin of safety either as regards life or the development of postoperative sequelae is quite as great in appendectomy cases as a general anesthetic offers. Fortunately I have had no unpleasant experiences myself with spinal anesthesia and I do not hesitate to use it when it seems to offer decided advantages over a general anesthetic, but I have had occasion to observe some of the undesirable postoperative sequelae of spinal anesthesia in an outpatient clinic to which are referred cases previously operated upon by other surgeons: persistent headache, backache, residual paralyses, sequelae of which the particular operator himself is almost necessarily profoundly unaware, and for this reason I have become a trifle apprehensive and cautious.

Operative Findings: The operative findings herewith recorded are taken from notes dictated at the time of operation. Because of the fact that in certain cases there were several associated abnormalities the classification about to be introduced is not altogether satisfactory, but inasmuch as any classification must of necessity ignore certain particular features of certain individual cases, in order to group the cases at all, the result must be a compromise. The particular abnormalities noted were distributed as follows:

Fibrous adhesions and associated angulations of the appendix	27 per cent
Fibrosis of the wall of the appendix with definite imprisonment of fecaliths	12 per cent
Unusual shortness of the meso-appendix and associated acute angulation of the appendix	10 per cent
Unusual fibrosis of the wall of the appendix in the absence of fecaliths	10 per cent
Funnel shaped appendix	10 per cent
Appendix showing definite evidences of subsiding acute inflammation	9 per cent
Fibrosis of the wall of the appendix with clubbing at the end of the organ	7 per cent
Appendix retrocecal and retroperitoneal	7 per cent
McKinley's bands	5 per cent
Fibrosis of the appendix causing definite circular constrictions	3 per cent

Associated or additional abnormalities included:

Noteworthy simple cysts of the right ovary	12 per cent
Noteworthy simple cysts of the left ovary	2 per cent
Meckel's diverticuli (not apparently inflamed or causing symptoms)	2 per cent

Wound Repair: In the entire series 92 per cent of the wounds underwent healing by primary intention, and by primary

intention is meant complete absence of secretion from the wound after about twelve hours and ultimate fine linear scar formation. Those wounds which required probing in order to evacuate small hematomas or seromas were considered as having undergone healing by second intention regardless of the ultimate appearance of the scar; of these there were 6 per cent. In 2 per cent of the cases the appendectomy wound became infected.

Postoperative Fever: The temperature charts of the cases have been summarized in two different ways. First the highest and lowest temperatures for each patient for each separate day were averaged and then the mean daily temperature of all the patients for that day was computed. Second the means of the highest and also of the lowest recorded temperatures for each successive day were computed. Temperatures were used for the day immediately preceding the operation and for five successive days thereafter. The postoperative fever reached its highest point within twenty-four hours following the operation and the temperature progressively and constantly decreased to its preoperative level on the fifth postoperative day.

Statistical Survey of Questionnaire and Personal Examination of Patients

On May 1, 1931, the following questionnaire was sent to all patients in the series who had been operated upon prior to this date. It will be noted that only 90 of the 100 cases were thus solicited. In the other 10 cases the operative date had been so recent that it was most unlikely that the patient's condition would have changed sufficiently since discharge from the hospital to make replies of any particular value.

1. Have you been relieved of your symptoms: Pain, nausea, and vomiting?
2. If you still have the same kind of symptoms you had before your operation did your operation relieve them temporarily? If so, for how long?
3. Is the scar of your operation painful?
4. Is the scar any wider than when you left the hospital? If so, how much?
5. Does your abdomen protrude in the region of the scar?
6. Do you suffer from constipation or diarrhea?
7. Have you borne any children or have you been pregnant since your operation?
8. Do you suffer from indigestion?
9. Are you satisfied with the result of your operation?
10. What does your Doctor think of the result of your operation?
11. What kind of work have you been doing since your operation?

Of the questionnaires dispatched 25 were returned as unclaimed, the postal authorities being unable to deliver the communication to the person addressed. Six were apparently delivered but were not answered, and 59 replies were received. Seven of the 59 patients presented themselves in my office for personal examination. In the remaining 52 cases results were compiled from the written statements of the patients alone.

Relief of Symptoms: Forty-two, or 71.2 per cent, of the patients who replied to the questionnaire reported that they had been completely and permanently relieved of symptoms and considered themselves well. The remaining 17 or 8.8 per cent of the patients reported incomplete relief of symptoms or no relief at all. The more significant statements culled from the replies are as follows:

1. "Relief for several months, but worse now"; this patient, however, has been pregnant for the past four and a half months and had been completely relieved of symptoms between the time of operation and the time of becoming pregnant.
2. Has "vomiting pains when the weather changes"; this patient has been pregnant for five months.
3. "Relief for a period after my operation but not long"; this patient has been pregnant for four and a half months.
4. "Relief for about three weeks"; this patient was personally examined by me.

She has been under hospital treatment for pyelitis and pelvic inflammatory disease since operation and has been pregnant for two and a half months.

5. "Relief for about three weeks."

6. "Was relieved for two months."

7. "Was relieved for three months, but symptoms have returned."

8. "Relief for about three months but now under doctor's care for the same thing."

9. "Was relieved for eleven months but now pain has returned."

10. "Was relieved for about a year."

11. Completely relieved for a year and a half but now "suffers from nausea."

12. Still suffers "from pain in the right side, nausea, and vomiting."

13. Suffers from "weak nerves and blind spells."

14. Has "pains in the right side" and gets "sick at the stomach."

15. Symptoms recur "during menstruation."

16. Has "pain only during menstruation."

17. "Well except for occasional attacks of nausea."

Without attempting in any way to minimize the fact that a considerable number of patients were not relieved of their symptoms, the foregoing statements and comments seem to indicate that the percentage of patients permanently relieved of their symptoms by the operation is at least not overstated by the figure given (71.2 per cent).

Pain in Scar: The operative scar was reported as being not painful by 43 patients, or 72.9 per cent, of cases. The remaining 16 cases, or 27.1 per cent, reported as follows:

1. "Scar is painful only since I have been pregnant."

2. "Scar is painful since I am pregnant."

3. "Scar was painful during pregnancy but not otherwise."

4. Occasionally has a "sharp pain in the scar which lasts for a few minutes."

5. "Scar is painful at times."

6. "Scar is painful" (5 cases); two of these cases have keloid formation in the scar according to their doctors.

7. "Scar is very painful."

8. "Scar is occasionally painful in cold weather."

9. "Half the scar is painful."

10. "Scar is tender but not painful."

11. "Scar is not painful, but sometimes there is a pinching sensation in it."

12. "Once the scar burned so badly I fainted."

Width of Scar: The scar was reported as being no wider than it was at the time of the patient's discharge from the hospital in 42 cases, or 71.2 per cent. The remaining 17 cases, or 28.8 per cent, reported as follows:

1. "Scar a little wider" (2 cases).

2. "Scar very little wider."

3. "Scar a least bit wider."

4. "Scar wider but not very much."

5. "Scar a little wider but so little you can hardly notice it."

6. Other cases estimated the width as $\frac{1}{16}$ inch (1 case), $\frac{1}{8}$ inch (2 cases), $\frac{3}{16}$ inch (2 cases), $\frac{1}{4}$ inch (1 case), and $\frac{1}{2}$ inch (3 cases).

7. In two cases keloid formation in the scar was reported by the patients' doctors.

Protrusion of Abdomen in Region of Scar: In 53 cases, or 89 per cent, patients reported no protrusion of the abdomen in the region of the scar. The remaining 6 cases or 10.1 per cent reported as follows:

1. Three patients simply stated that the abdomen did protrude in the region of the scar, but two of these are said by their doctors to be suffering from keloid formation.

2. "Abdomen protrudes a very little in one place."

3. "Abdomen protrudes a little."

4. "Abdomen protrudes a little."

Constipation and Diarrhea: Of the 59 patients 42, or 71.2 per cent, reported that they suffer from neither constipation nor diarrhea. The remaining 17 patients, or 28.8 per cent, state that they suffer from

constipation but not from diarrhea. In one case previously existing constipation was relieved by the operation; in another case, constipation has been a symptom only since operation.

Pregnancies: Five of the patients report that they are pregnant at present. Of these, three are having untoward abdominal symptoms and two have no such symptoms. Two patients were pregnant at the time of operation and delivered uneventfully (one gave birth to twins). Five have become pregnant and have given birth to children since their operation. Their deliveries were uneventful; one reports also an intermediate miscarriage.

Indigestion: Thirteen patients or 22 per cent report that they suffer from indigestion. In most cases, it is stated that the indigestion occurs only on rare occasions and is not attributed to the effects of the operation. In the other cases, the indigestion is associated with pregnancy or with a preexisting condition which the operation failed to relieve. In no case was the indigestion of postoperative origin unless associated with pregnancy.

Patient's Estimation of Success of Operation: Fifty-one patients, or 85.6 per cent, expressed complete satisfaction with the results of the operation. The comments of the eight patients, or 14.4 per cent, who expressed dissatisfaction are abstracted:

1. "Was satisfied until I became pregnant" (2 cases).
2. "I am not well at all."
3. "I am under another doctor's care."
4. "I am not quite satisfied."
5. "No" (2 cases).

Family Physician's Estimation of Success of Operation: Only 40 of the 59 patients had been examined by private physicians since their operations. Of those who had consulted their own physicians, 35 patients, or 87.5 per cent, stated that the physician who examined them was completely satisfied with the result. A resume of the unfavorable replies follows:

1. "Doctor said something was done wrong at operation." This patient at the time had been under treatment for pyelitis and acute pelvic inflammatory disease.
2. "Doctor said it was a bad scar"; the patient herself says, however, that she has been completely relieved of symptoms, has borne a child and is entirely satisfied with the result of the operation.
3. "Doctor says the result is good except for keloid."
4. "Doctor says I'll never be relieved of pain."
5. "Doctor says it's the first time he ever saw an operation that way" (scar transverse).

Patients' Activities since Operation: Almost all of the patients state that their activities include housework, but many have other duties besides: such as, "cutting sugar cane," "packing berries," "working in a restaurant," "working as clerk in a store," "farmwork," "chopping cotton," "working in a salt factory," "hoeing in the field," "any work a woman can do." Eight patients go to school, three work only in a factory and three work only as clerks. Only three patients have no stated duties.

Discussion and Conclusions

It is not maintained and it should not be considered as implied that this survey makes a case for the superiority of the transverse incision. In fact, were the series of operations many times as extensive and the analysis far more exhaustive, the way would still be open for many differences of opinion. Certainly the percentage of satisfactory results obtained in any series of operative cases is not necessarily a safe criterion of the excellence of operative technique for many reasons, a very obvious one being that unless the procedure which is used is adapted to the actual abnormality responsible for the patient's symptoms, it cannot succeed; accordingly the problem of relief of symptoms is fundamentally a matter of correctness of diagnosis. All that is claimed for the present survey is that it is believed to demonstrate the general feasibility of the technique suggested and the relative freedom of the procedure itself from undesirable complications and sequelae.

The series of statistics which have been

recorded has been collected with the utmost sincerity and no attempt has been made to conceal the less complimentary side of the picture. I believe it is of some significance that although only 71.2 per cent of the cases stated that they had been completely relieved of symptoms, 85.6 per cent expressed themselves as entirely satisfied with the results of the operation. Although certain of the patients stated that the abdomen protrudes slightly in the region of the operative scar, I believe none of these protrusions represents postoperative herniation; I personally examined three of these patients and the protrusion was extremely slight; at all events I have never seen a case of postoperative herniation through a transverse appendectomy incision. Although the width of abdominal scars and their general unsightliness is perhaps a minor matter in comparison with functional excellence, there can be little question but that the transverse scar shows less tendency to widen and become increasingly apparent with the passage of time than any other.

Finally, I have been keenly interested in attempting to analyze the causes of failure in those cases in which the end result of operation was unsatisfactory. Apart, however, from the rather superficial observation that in some cases dissatisfaction arose only during a subsequent pregnancy, the result of this analysis has yielded little of especial interest. As far as those cases which I have not been able to examine personally are concerned, careful perusal of the case histories gives little clue to the causes of failure; this is illustrated by the following three condensed case histories:

Case I. R. D., operated upon June 17, 1930. Age sixteen years. Duration of symptoms: twelve months. Last attack: seventeen days ago. Chief complaint: Pain in the epigastrium radiating to the right lower quadrant of the abdomen. No nausea but has vomited several times. No constipation. No other complaints. Leucocyte count 10,000, with 72 per cent polymorphonuclear leucocytes. Urinalysis negative. At operation about 100 c.c. of clear straw-colored fluid welled up into the wound. Definite Jackson's veil. Cystic left ovary. Postoperative temperature at its highest on the third day, 100.4°F. Temperature normal on fourth day. Wound healing by primary intention.

Case II. S. C., operated upon July 8, 1930. Age twenty years. Duration of symptoms: thirteen months. Last attack: six days ago. Pain in both lower quadrants of the abdomen radiating to the back, no nausea, no vomiting, severe constipation. Also complains of dizziness and frequency of urination. Leucocyte count: 9800, 64 per cent polymorphonuclear leucocytes. Urinalysis negative. Upon opening the abdomen, considerable clear, yellow, straw-colored fluid. Many adhesions about the appendix. The organ was both retrocecal and retroperitoneal and was acutely angulated in its midportion. Small hematoma evacuated from the wound on the third postoperative day. Postoperative fever at its height on the fourth postoperative day, 100.2°F. Normal on fifth postoperative day.

Case III. L. N., operated upon March 1, 1930. Age sixteen years. Duration of symptoms: eight years. Last attack ten days ago. Pain in the right lower quadrant of the abdomen. Considerable nausea and vomiting, suffered severely from constipation. Patient faints occasionally. At one time, feces were positive for hookworm but treatment for hookworm has failed to relieve the symptoms. Leucocyte count 10,500, 72 per cent polymorphonuclear leucocytes. Urinalysis revealed few epithelial cells, occasional pus and red blood cells. Appendix long, of small caliber, with definitely fibrotic walls and retrocecal. Postoperative fever at its height on the fourth postoperative day, 99.6°F., normal on fifth. Operative wound healed by primary intention.

In the three cases of unsatisfactory end result which I have had occasion to examine, the findings were as follows:

Case I. Patient subsequently under treatment in the hospital for right-sided pyelitis; recently married and has contracted gonorrheal endocervicitis and bilateral salpingitis.

Case II. Patient sixteen years old, very much overweight and apparently suffering from a lipo-dystrophy.

Case III. Patient is suffering from pulmonary pthisis as shown by skiagrams; sputum positive for acid-fast bacilli.

In short, in no case has the operative procedure itself seemed to have been responsible for untoward results except possibly in association with the formation of postoperative intra-abdominal adhesions.

CHRONIC CYSTIC ARACHNOIDITIS*

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THE symptoms of lesions of the brain produced by tumor, abscess, aneurysm, and localized areas of inflammation have been designated the "brain tumor syndrome" because neoplasms predominate as the causative factor. The significant clinical features of the syndrome are headache, vomiting, and choked disks associated with failing vision, and any one, or a combination of these, may suggest a diagnosis of tumor of the brain.

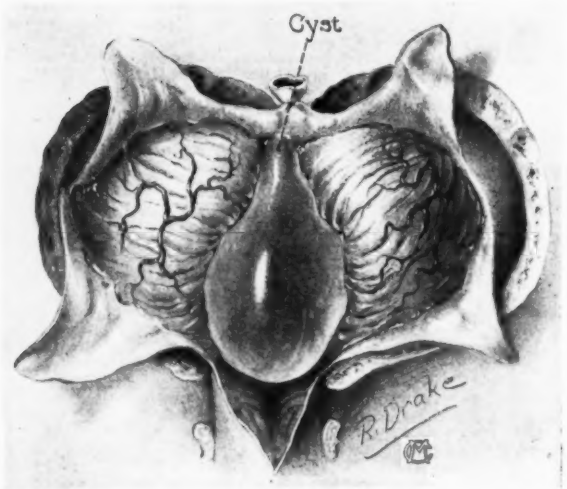

FIG. 1. Case 1. Inflammatory cyst completely blocking fourth ventricle.

Probably the smallest and most interesting group of cases in which this syndrome is a background for its symptoms is that of inflammatory lesions of the brain and meninges. The entire clinical course from onset to operation is that of an indeterminate lesion of the brain so closely simulating the history and development of a tumor of the brain that a differential diagnosis is very difficult and is usually made at the time of operation. The lesion is usually an inflammatory one confined to the arachnoid, and is evidently a residue from a previous attack of meningoencephalitis.

These inflammatory lesions may involve the cerebral hemispheres, and produce Jacksonian convulsions or paresis of one or both extremities on the opposite side. They may involve the optic chiasm and produce decreased visual acuity or defects in the visual fields, or they may involve the posterior fossa and produce intracranial hypertension and symptoms of cerebellar involvement.

In some of the cases, there may be a history of previous nasopharyngeal or pulmonary infection suggesting an inflammatory lesion, but the development of symptoms is frequently so similar to that of a fairly rapidly growing tumor of the brain that no preoperative indication of the underlying pathologic change is obvious. Regardless of the pathologic etiology, operation is the only satisfactory method of treating increased intracranial pressure, as well as localized lesions of the brain which are not degenerating.

Chronic arachnoiditis occurring in the posterior fossa so interferes with the escape of cerebrospinal fluid that increased intracranial pressure, internal hydrocephalus, and the resulting papilledema, or choked disk, with failing vision may necessitate early surgical intervention to prevent permanent injury to vision due to secondary optic atrophy.

Horrax[1] has called attention to the fact that apparent arachnoiditis may be associated with a tumor in the posterior fossa, but before a definite diagnosis can be made, a careful search should be instituted at

[1] HORRAX, G. Generalized cisternal arachnoiditis simulating cerebellar tumor: its surgical treatment and end-results. *Arch. Surg.*, 9: 95–112, (July) 1924.

* Submitted for publication June 10, 1932.

the time of operation for any associated neoplasm. The ultimate test, however, depends on the subsequent history of

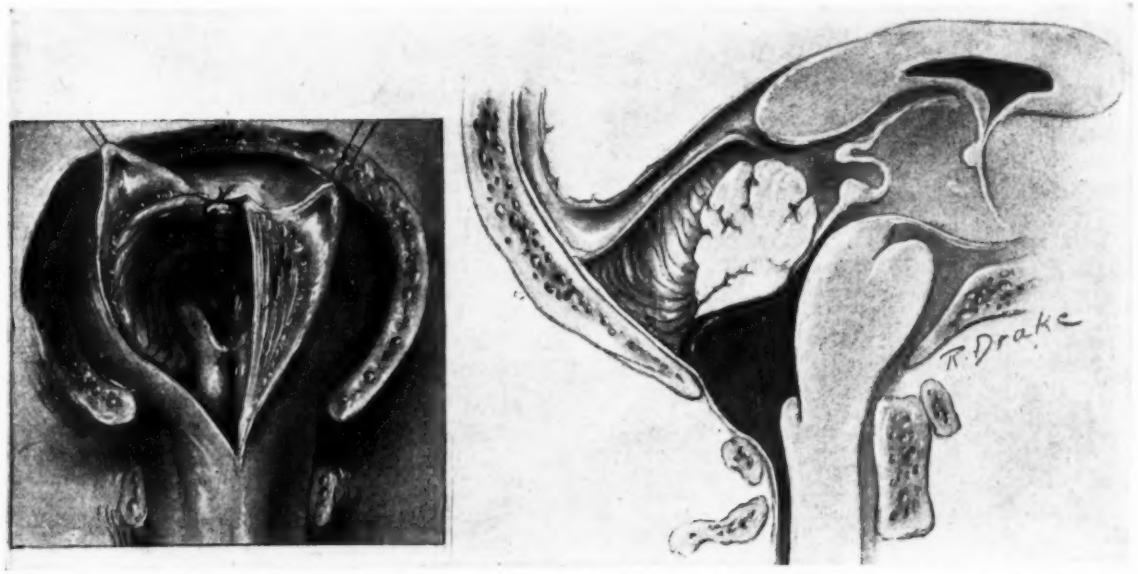

Fig. 2. Case 11. Arachnoiditis producing internal hydrocephalus and simulating tumor of posterior fossa.

relief. Arachnoiditis of the cisterna cerebromedullaris probably responds better to surgical treatment than any other inflammatory cerebral lesion because by relieving intracranial hypertension and reëstablishing the flow of cerebrospinal fluid, the symptoms immediately disappear and the papilledema recedes, preventing or arresting any tendency toward secondary atrophy of the optic nerve and loss of vision.

In order to illustrate the difficulties encountered in the diagnosis of these lesions and to present the clinical results following operation, as well as to emphasize the necessity of early operation, three cases of cisternal arachnoiditis are being used for comparison and contrast.

REPORT OF CASES

Case 1. A woman, aged twenty-three years, came to The Mayo Clinic complaining of headaches, failing vision and ataxia. She had apparently been in excellent health until one and a half years previous to registration, when she first noted blurred vision of the left eye. She had had no further symptoms until nine months prior to examination when she experienced a sudden, severe headache over the frontal region, extending into the occipital region and radiating down the neck. After a few days, the headaches subsided until seven months before registration when they began to occur at weekly intervals. The headaches came on suddenly at 4 or 5 A.M. and lasted from one to twelve hours. They were described as "bursting," and were so severe that she was forced to remain in bed. They gradually grew more severe and frequent and were accompanied by double vision, projectile vomiting, and buzzing in the ears; about this time, she also noted sudden attacks of vertigo on changing position. For the previous three months, she had been unable to read because of marked failure of vision of both eyes. She had also noted progressive awkwardness of the left foot and left hand, associated with a marked feeling of lassitude.

Examination revealed that the patient was apparently in good physical condition with little loss of weight; she was unable to see very well and walked with a staggering gait. Urinalysis, blood count, and Wassermann reaction of the blood gave negative results. A roentgenogram of the head was negative, but one of the thorax revealed healed tuberculosis of the apex of the lobe of the right lung. The vision of the left eye was reduced to counting fingers, and that of the right eye to moving objects. The fundi revealed the presence of bilateral choked disks of 7 diopters in the right

eye and 6 diopters in the left eye, with hemorrhages and exudates and commencing pallor. Neurologic examination was essentially negative except for slight ataxia and incoördination. Because of the extreme intracranial pressure, and the paucity of localizing signs, ventriculography was advised.

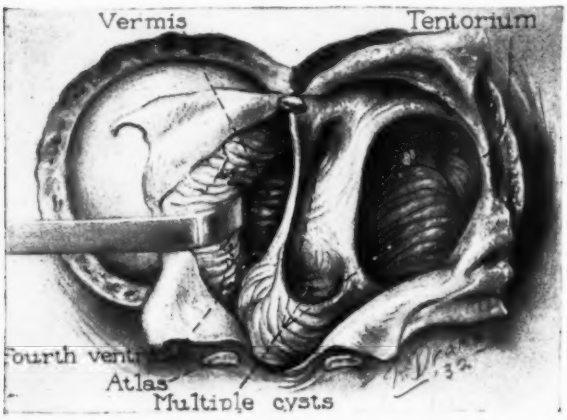

FIG. 3. Case III. Multiple inflammatory cysts of posterior fossa associated with inflammatory condition of lungs.

The lateral and third ventricles were found to be dilated, which indicated obstruction in the ventricular system, probably in the posterior fossa, and a suboccipital exploration was carried out through a cross-bow incision. On incising the dura, a large inflammatory cyst, 5 cm. in diameter, was found lying in the fourth ventricle and posterior cistern, associated with chronic cystic arachnoiditis (Fig. 1). The arachnoid could be incised, and the cyst was found to be inclosed in a membrane resembling the arachnoid. The cyst was aspirated and its walls were completely removed from the fourth ventricle. Following this, the cerebrospinal fluid, colored by the indigocarmine, could be seen escaping into the fourth ventricle.

After an uneventful convalescence, the patient was allowed to return home. The papilledema had receded to 2 diopters in each eye at the time of dismissal, and her general condition was excellent.

The condition of the patient was followed with a great deal of interest, because of the beginning atrophy of the optic nerve, and the extremely high papilledema. A letter three years after operation reported that she was in excellent physical condition; her vision, although still not perfect, was definitely improved and she could get about and do housework, but could not do close needlework or read fine print.

There was nothing in the early history in this case to indicate the presence of an inflammatory lesion, and the method of onset so simulated a tumor in the posterior fossa that it required exploration to determine the cause of the disability. Comment on the treatment of this case would consist of criticism of the delay of operation, since the atrophy of the optic nerve, which was present at the time of the operation, prevented the vision from returning to normal. This case illustrates the need for early diagnosis of intracranial lesions and immediate operation.

CASE II. A girl, aged eighteen years, registered at the clinic because of headaches, nausea and vomiting. She had been perfectly well until one year previously when she had had a sudden attack of severe headache. The pain was described as dull, pressing and tight, and confined to the frontal region, becoming progressively worse and associated with nausea and projectile vomiting. The attack lasted twelve days, following which she was extremely dizzy when she sat up; she also complained of tinnitus in both ears, blurred vision and diplopia. A spinal puncture at this time revealed increased pressure of the cerebrospinal fluid; there was complete relief of all symptoms following spinal drainage. She was free of symptoms until a second attack occurred, ten months later, which was similar to the first attack and was relieved by spinal puncture. However, the third attack came on two months later and had not been relieved up to the time of her admission to the clinic.

Examination revealed that the patient was apparently in good physical condition except that headaches confined her to bed. Urinalysis, blood count, and Wassermann reaction of the blood gave negative results. Roentgenograms of the head and thorax were negative. On examination of the eyes, the perimetric fields and ocular movements were normal, but the fundi revealed bilateral acute choked disks of 3 diopters, with hemorrhages and exudates. Neurologic examination was negative except for loss of abdominal reflexes and the presence of a bilateral Babinski reflex.

A diagnosis was made of unlocalized lesion of the brain with increased intracranial pressure, and ventriculography was advised. The roentgenograms showed the presence of internal hydrocephalus with a dilated third ventricle, indicating a lesion in the posterior fossa. Consequently, a suboccipital exploration was performed through a modified cross-bow incision and the dura was found markedly thickened, injected and very tense. The arachnoid was thickened and the seat of an inflammatory reaction (Fig. 2). The fourth ventricle was slightly dilated and there was no sign of tumor. In order to test the patency of the ventricular system, air was injected into the lateral ventricle and was found to bubble through into the fourth ventricle. A diagnosis was made of chronic cisternal arachnoiditis and the wound was closed.

The patient had a very stormy convalescence, but at the time of her dismissal, her condition was definitely improved. The papilledema had receded, and the headaches, nausea and vomiting had been relieved. A letter received three years after her return home reported that she had recovered completely.

This case is interesting from the standpoint of treatment, for the first attack was relieved by drainage of spinal fluid after it had been found to be under increased pressure. A second attack was relieved by the same method, but the third attack did not respond so satisfactorily and operation revealed the cause. Had this case been allowed to proceed further before instituting surgery, vision would probably have been affected much the same as in the first case, but the relief of pressure prevented the papilledema from progressing to atrophy of the optic nerve. The report of the patient's condition three years after operation confirmed the diagnosis and emphasizes again the necessity for early operation.

Case III. A girl, aged nine years, was brought to the clinic because of headaches, projectile vomiting and blurring of vision. She had apparently been normal at birth; delivery had been instrumental and at full term. Her growth and development had been normal although her appetite had never been good. The present illness began with a very severe cold contracted six months previous to examination. This was followed by bronchitis and persistent cough. Five months before registration, she had had intermittent and severe frontal headaches, localized over the right side of the forehead and right eye, and extending back into the occipital region. Three weeks before admission, attacks of vomiting began to occur once or twice daily, and a week later, diplopia and blurring of vision developed. She had to remain in bed for three weeks before coming to the clinic.

On examination, it was apparent that the patient was extremely sick and undernourished. The head was tilted to the right and there was a frequent hoarse cough. Urinalysis, blood count, and Wassermann reaction of the blood gave negative results. A roentgenogram showed rather marked infiltration of the left middle and lower part of the thorax. These changes suggested an abscess of the lung or possibly a primary malignant lesion. The roentgenogram of the head revealed increased intracranial pressure with separation of the sutures. Vision was found to be 6/12 in the left eye and 6/30 in the right eye. The pupils were equal and the reflexes were normal. The perimetric fields were normal. Examination of the fundi revealed bilateral choked disks of 3 to 4 diopters with hemorrhages and exudates. On moving the head, the neck was stiff and rigid. Neurologic examination revealed definite weakness of the soft palate and pharynx on the left. The reflexes in both the upper and lower extremities were greatly diminished and Babinski, Mendel-Bechterew, and Schaeffer signs were positive on both sides. The gait was markedly ataxic and there was definite incoördination of movements.

In this case of definite symptoms of increased intracranial pressure, due probably to a lesion in the posterior fossa, diagnosis was difficult. The history of coughing and the roentgen-ray evidence of a pulmonary lesion immediately suggested primary malignancy or abscess of the lung with metastasis to the brain. For that reason, bronchoscopy was done which revealed an inflammatory, non-purulent pulmonary lesion. The patient was immediately hospitalized, given daily inhalations of steam, cod liver oil, 1 per cent creosote, hypertonic solution of glucose intravenously, and enemas of magnesium sulphate. Under this treatment, the

cough improved, the vomiting stopped, and the child was able to take nourishment by mouth.

After the patient had been on medical treatment for two weeks, and a second roentgen-ray examination showed improvement in the pulmonary condition, it seemed advisable to proceed with an exploration of the posterior fossa. Because of the pulmonary complications, the patient was given pentobarbital sodium, grains 1½, the morning of the operation, and after she was brought to the operating room, tribromethyl alcohol was given by rectum. Then, under regional anesthesia, a median line incision was made over the cervical and suboccipital region, and after the periosteum had been reflected, bilateral cerebellar exploration was performed, which exposed a very tense, fibrous reddish dura. Cerebrospinal fluid was allowed to escape from the posterior horn of the left lateral ventricle which relieved the pressure and allowed the dura to be incised. A large multilocular inflammatory cyst occupying almost two-thirds of the posterior fossa could be seen pushing the vermis and a portion of the right cerebellar lobe across the median line (Fig. 3). The tonsilla cerebelli and vermis were covered with vascular adhesions. The cyst was opened and it was possible to strip the wall from the cerebellum and the dura. The wound was closed in the usual manner and the patient was returned to her room.

Convalescence was gratifyingly uneventful; the patient was allowed out of bed on the twelfth postoperative day and went home on the seventeenth day. At the time of dismissal, the papilledema had receded to a point where it was no longer measurable. Roentgenograms of the thorax showed almost complete absence of infiltration. Six months later, a report stated that she had gained in weight, her cough had disappeared, and she was able to run and play without ataxia, dizziness, or blurring of vision.

This case is outstanding in many respects. It differs from most cases of arachnoiditis in that there was a definite history of pulmonary infection which preceded the intracranial symptoms and indicated the nature of the lesion. However, this predisposing factor added to the difficulties of diagnosis, simulating an abscess or a malignant lesion of the lung, and necessitating bronchoscopic examination before the true nature of the lesion could be determined. The medical treatment combined with the hypertonic regimen no doubt played an important part in the successful surgical result, for in intracranial operations, as well as in gastric, thyroid and other types of operation, the advantage of preoperative treatment is being learned. The type of anesthetic also contributed to the success of the operation, for had any one of the general anesthetics been tried, the pulmonary condition would probably have caused further trouble, but a combination of pentobarbital sodium given to the patient in her room to allay any excitement previous to coming to the operating room, the tribromethyl alcohol to produce relaxation, and the regional anesthetic to prevent undue stimulation during the operation, gave a splendid result.

The symptoms observed in these three cases are probably representative of most of the phases of diagnosis and of the difficulties encountered in treatment of inflammatory intracranial lesions which comprise the classification of chronic cisternal arachnoiditis.

SOME RADIOGRAPHIC ASPECTS OF URINARY CALCULI*

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THE composition of urinary calculi as reported by various investigators in different parts of the world differs widely. There is some difference of opinion as to whether urates or oxalates are the more frequently found constituents of stones in the urinary tract. It is maintained by many that calcium oxalate is the most predominant of all types of calculi and that uric acid, urates, phosphates and carbonates follow in the order given. In Iwano's series of 487 calculi of the urinary tract, calcium oxalate stones were in the majority. Of 545 calculi analyzed by Ultzman 80.9 per cent were uric acid, 8.6 per cent phosphates of alkaline earths, 5.6 per cent calcium oxalate, 3.3 per cent some foreign body and 1.4 per cent cystine. In a series of 207 calculi investigated by the author at the Brady Foundation for Urology at the New York Hospital the following results were secured:

FIG. 1. Plain *x*-ray showing no definite shadows of calculi.

FIG. 2. Pyelogram of same case showing several filling defects. Calculi found at operation.

		Per Cent
Calcium oxalate	106	51.3
Phosphates	79	38.2
Uric acid	16	7.7
Cystine	6	2.9

The oldest known calculus of the urinary tract in man, about 7000 years old, consists of a nucleus of uric acid and an outer portion of calcium oxalate and triple phosphate. It was found in 1901 by Elliott Smith in a pre-historic tomb at El Amrah,

* From the Brady Foundation for Urology, New York Hospital. Submitted for publication March 2, 1932.

near Abydos, and was discovered in the pelvis of a boy of about sixteen.[1]

Of factors determining the predominant type of calculus in any geographical location diet is probably the most important. It is thought by many that the absence of the fat-soluble vitamin predisposes to stone formation. Among the Japanese and Chinese, whose diet is deficient in this vitamin, calculus disease is very common, while among the Esquimaux, calculi are almost never found. However, the problem of stone formation in the human body is far from complete solution.

In 1897, Swain[2] published a case in which diagnosis was made by means of the roentgen ray of a calcium oxalate renal calculus, measuring $1\frac{1}{8} \times \frac{7}{8} \times \frac{5}{8}$ inches. He stated that this was the first case of calculus definitely diagnosed by *x*-ray but he ventured the prophecy that it was only a matter of time until a more extended knowledge would render it possible to prove graphically the existence of calculus, not only in the kidney, but also in the urinary bladder, gall bladder and intestine.

Swain did considerable work in determining the irradiability outside the human body of calculi of different composition and was the first to experiment along this line although Chapins and Chauvel were the pioneers in the study of renal calculi by means of the roentgen ray. Swain tabulated his results with calculi of various types as follows:

Fig. 3. Cystine calculus.

Fig. 4. Two calculi in ectopic (pelvic) kidney.

Specific Gravity	Permeability to *X*-ray	Density of Shadow
Calcium oxalate	Biliary calculi	Calcium oxalate
Uric acid	Uric acid	Phosphates
Phosphates	Phosphates	Uric acid
Biliary calculi	Calcium oxalate	Biliary calculi

Swain also showed that short exposures were better than long ones and that calcium oxalate and calcium phosphate calculi showed most plainly. He was at a loss to explain why calcium oxalate calculi were

so common in Bristol and took no stock in the common belief that this situation was due to the character of the water supply. Some expressed the opinion that the condition was due to loose living among the inhabitants of Bristol but Swain said that it was difficult to believe that Bristolians were so much more self-indulgent than their fellows as to account for their increased liability to "mulberry" calculi.

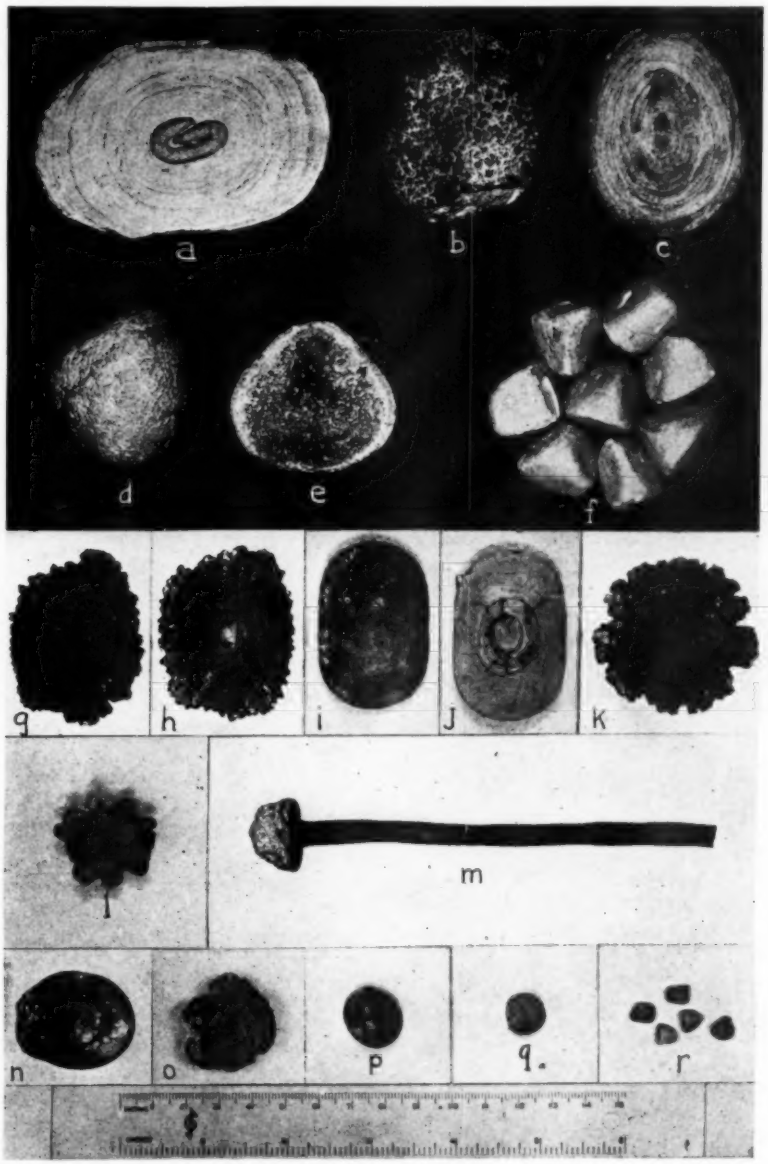

Fig. 5. Gross appearance of group of calculi of various compositions. (From Young and Waters.[7])

a, calcium phosphate: *b*, uric acid with small amount of calcium oxalate; *c*, cross section of *b*; *d*, outer layer calcium phosphate, nucleus calcium oxalate and phosphate; *e*, cross section of *d*; *f*, calcium oxalate, carbonate and phosphate; *g*, calcium oxalate; *h*, cross section of *g*; *i*, uric acid with small amount of calcium oxalate; *j*, cross section of *i*, shell and nucleus examined; *k* and *l*, calcium oxalate; *m*, calcium phosphate deposits on mushroom catheter; *n*, calcium phosphate; *o*, calcium oxalate; *p*, uric acid; *q*, calcium oxalate; *r*, calcium oxalate, trace of uric acid.

Too much in turtle Bristol's Sons delight;
Too much o'er bowls of rack prolong the night:
If commerce fills the purse, she clogs the brain,
And Amos Cottle strikes the lyre in vain.[3]

A. Béclère[4] tabulated the atomic weights of the elements entering into the composition of calculi and stated that the radiability of calculi varies with the atomic weights, those made up of elements of low atomic weight having a slight power of absorption of roentgen rays. In the case of various salts, as carbonates, urates and oxalates, the power of absorption of the roentgen ray increases with the atomic weight of the metal entering into the composition; e.g., one can arrange the urates in order of their increasing capacity to absorb roentgen rays as follows: urate of ammonia, sodium urate, magnesium urate, potassium urate and calcium urate. Because of their greater atomic weight, the salts of calcium have a power of absorption greater than that of salts of other bases. The atomic weight is not the only factor to be considered, however, as the number of atoms, in other words, the molecular structure, is also important.

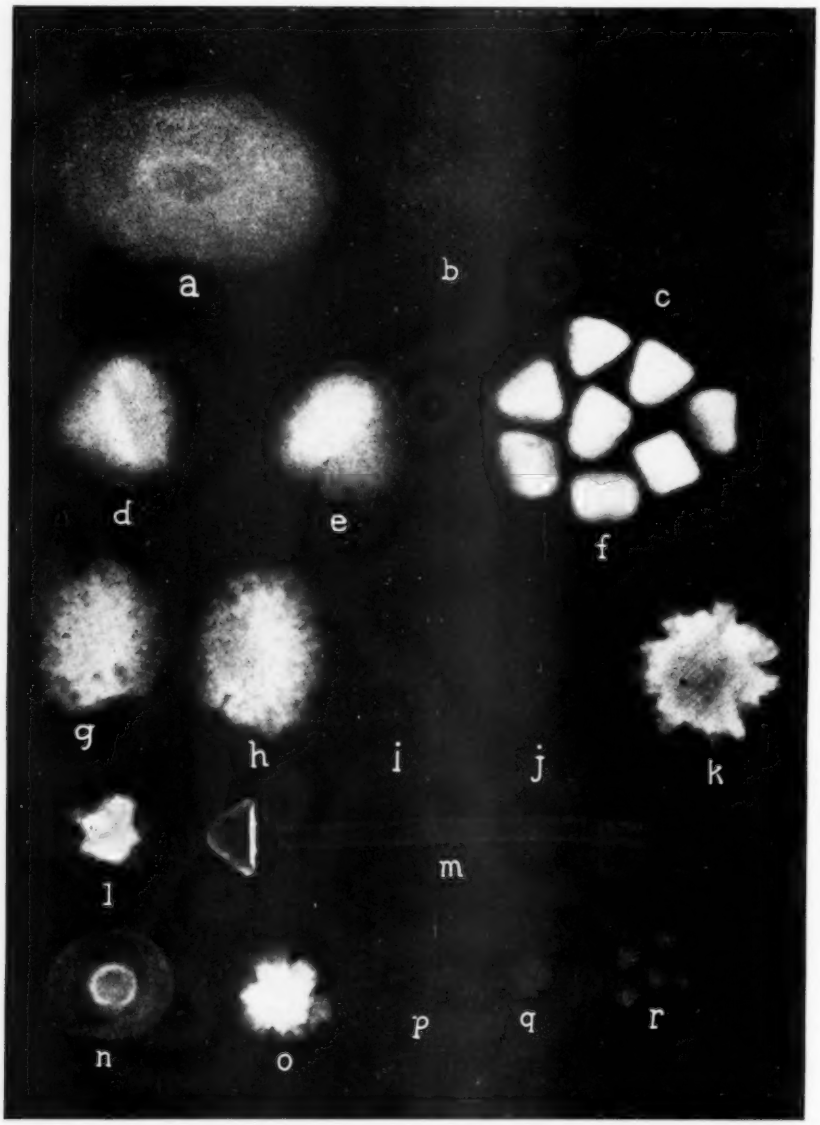

Fig. 6. *X*-ray appearance of same group of calculi. (From Young and Waters.[7])

In calculi, layers of different density may alternate; e.g., a urate layer may alternate with a phosphate or oxalate layer. In this way a calculus could cast a shadow having the appearance of concentric circles.

About 10 per cent of urinary calculi cast no shadows at all. This is a point that many general physicians fail to recognize so that sometimes we have a patient come to us and say, "Dr. Jones thought I had a stone but the *x*-ray did not show it and so he said it must be something else." In some of these cases we nevertheless find filling defects in the pyelograms and remove calculi at operation. Such a case is illustrated in Figures 1 and 2. In Figure 1, a plain plate, no definite shadows indicating calculi are seen. In Figure 2, the pyelogram shows several filling defects which, at operation, were proved to be due to uric acid calculi.

The majority of calculi casting no shadow consist either entirely or largely of uric acid. When pure, a uric acid calculus gives rise to no shadow or to a very faint shadow. When visible, the density is usually due to contamination. Beer estimates that about 10 per cent of all urinary calculi consist of uric acid.

Calcium oxalate and phosphate stones cast a good shadow. Calcium carbonate stones are more frequent in lower animals than in man, but when found, cast a good shadow.

Cystine stones, if pure, cast faint shadows (Fig. 3). If they contain impurities the shadows may be quite definite. There are six cases of cystine calculi in the series classified at the beginning of this article. Three of these six cases of cystine stones have been previously reported by Henline.[5]

Xanthin and cholesterin stones are very rare and cast only faint shadows.

Soft stones in the urinary tract are rare. Hyman[6] reported three cases of soft vesical stones which consisted of albumen, fibrin, bacteria and amorphous material mixed with urinary salts. In Hyman's cases the stones followed cystitis, subsequent to prostatectomy.

Small stones may not cause definite displacement of the medium employed. Usually, a stone must be at least 1.5 cm. in diameter to cause a recognizable filling defect. For this reason some small calculi are missed even after a complete urologic investigation.

Figures 5 and 6 are used through the courtesy of Dr. Hugh Young and Dr. Charles Waters.[7] These figures give a very excellent idea of the *x*-ray appearance of various types of calculi.

Some pyelographic media, such as colloidal silver, impregnate the stone so that its outline is visible several hours after pyelography. The iodide solutions usually employed today do not cause such impregnation.

Biliary calculi must be differentiated from those of the urinary tract. This is usually not difficult as biliary calculi are often in group formation, are more mobile and are in most instances more opaque around the periphery than at the center. The fact that a patient may have both biliary and renal calculi should not be overlooked. The author had such a case recently.

The position of calculi may at times be deceptive due to renal ptosis, double pelvis, horseshoe kidney or ectopic kidney. The author[8] has reported a case of two calculi in an ectopic (pelvic) kidney. This case occurred on the service of Dr. O. S. Lowsley at the New York Hospital. The calculi are shown in Figure 4.

The most common sources of error in the *x*-ray diagnosis of calculi are as follows:

1. Faulty *x*-ray technique.
2. Motion or breathing on part of the patient.
3. Presence of gas in the intestines.
4. Overlapping of calculus and bone shadows.
5. Obesity of the patient.
6. Failure to make a complete cystoscopic examination with pyelogram.
7. Inexpert interpretation of the plates.

SUMMARY

The density of the shadow cast by a calculus varies with the atomic weight of the chemical elements of which the calculus is composed.

The composition of a series of 207 calculi is reported. Calcium oxalate stones predominate in this series.

Certain types of stones cast no shadows or very faint shadows.

A complete urological examination with pyelography is often necessary to rule out the presence of calculus.

Sources of error in the *x*-ray diagnosis of calculi are pointed out.

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*Continued from page 363.

RENAL DYSTOPIA

A REVIEW OF 343 CASES*

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THE insecure renal attachments, the structural anatomy of related parts and the generally lax physical habits are responsible in a large degree for renal dystopia and its attendant aggravating symptoms. Ptosis was first described in the fifteenth century, since then much has been written and various therapeutic measures advocated, most of which have been surgical. However, the frequency with which the condition has been found in the clinic (Woman's Hospital, Detroit) and the success of the non-surgical treatment employed, has led us to believe that a careful study of the case records of these patients might be of interest; accordingly we herewith present a résumé of 343 cases that have been under our care in the past few years. These patients have had a

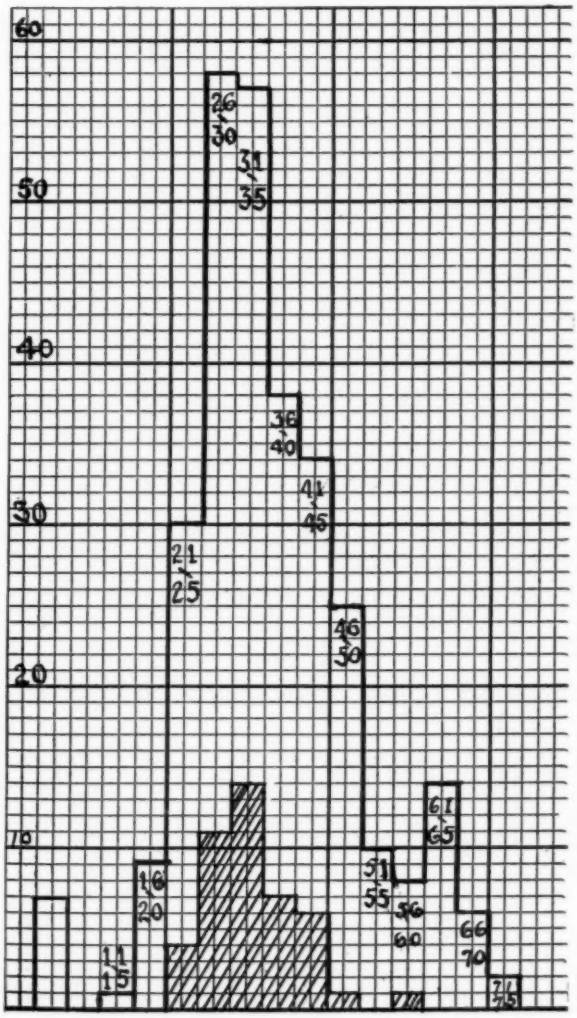

FIG. 1. Age incidence, males and females. Males in shaded portion.

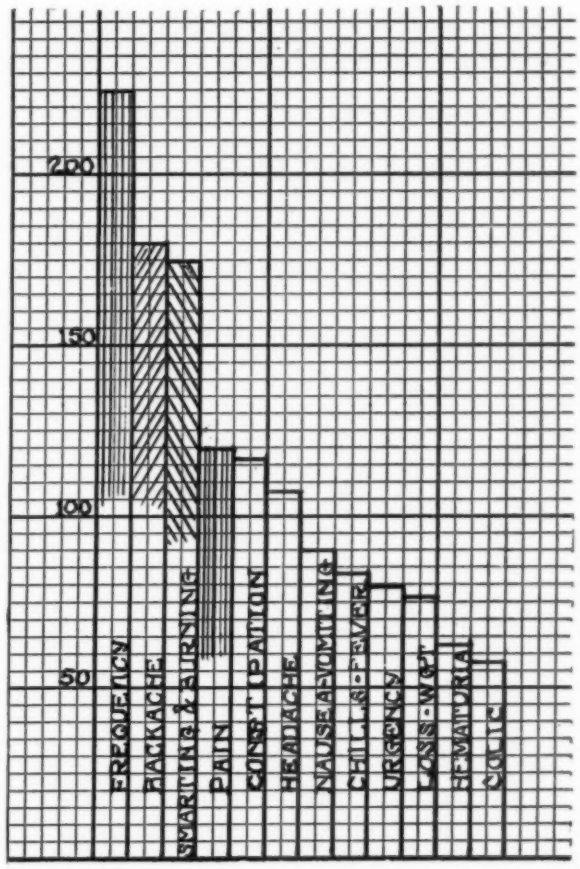

FIG. 2. Relative occurrence of symptoms in all cases.

* Submitted for publication December 22, 1931.

rather careful follow up which has assisted in completing the records.

Renal dystopia is rather difficult to define except relatively. If the normal respiratory excursion of the kidney is from 1.5 to 5 cm., then any excess of this behind the peritoneum may be considered abnormal. Glenards' classification is as follows:

First degree: When the lower pole of the kidney can be felt on deep inspiration.

Second degree: When the kidney can be grasped near the middle on deep inspiration and held.

Third degree: When the entire kidney can be grasped and the hand pushed above the upper pole.

However, we feel that the careful interpretation of *x*-ray films is the most valuable aid in determining the degree of dystopia, and the degree of ptosis should be measured on the films. In an earlier publication, one of us (H.L.M.)[1] laid special stress upon the necessity of establishing the *exact* amount of motility of the kidneys in all affections of the higher urinary tract.

The severity of the symptoms is not always in direct proportion to the degree of dystopia. In fact patients having renal dystopia may be symptom free, especially uncomplicated cases. If the condition is discovered during the course of routine examination it perhaps would be inadvisable to inform the patient for obvious reasons. Conclusions should be arrived at only after careful, complete, and intelligent urological examination.

The entire surface of the kidney is covered by a thin, strong fibrous capsule, which dips down into the sinus and becomes adherent to the renal vessels. Next to the fibrous capsule is the perirenal fat which completely surrounds the organ. The renal fascia, which is one of the principal means of fixation of the kidney, is developed from the subperitoneal tissue lying between the transversalis fascia and the peritoneum. This fascia splits into two layers at the lateral border of the perirenal fat. The posterior layer passes anterior to the psoas muscle and posterior to the aorta where it fuses with the heavy

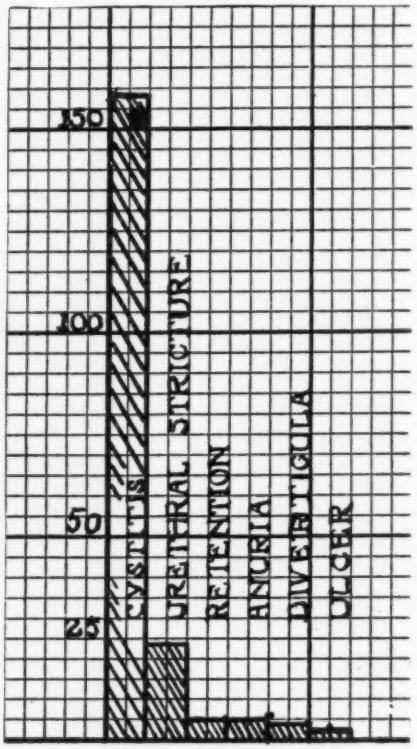

Fig. 3. Cystoscopic findings in all cases.

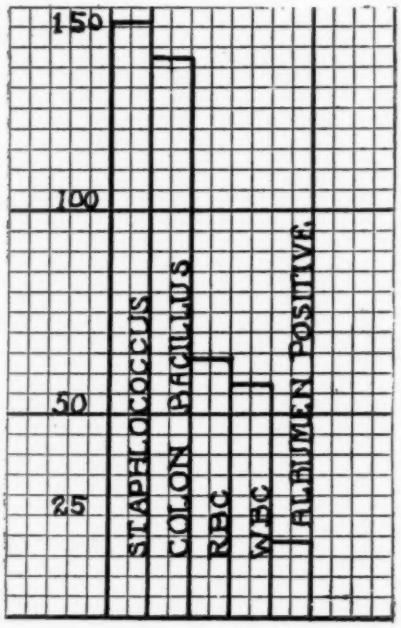

Fig. 4. Laboratory findings in all cases.

connective tissue in front of the vertebral column. The anterior layer, which is thinner than the posterior, passes over the renal vessels and aorta and becomes continuous with the corresponding layer of the opposite side. The left anterior layer is somewhat stronger than that on the right, due to the doubling over of the mesocolon during development. Both layers are attached to the fibrous capsule by fine trabeculations traversing the fatty capsule. Superiorly the layers pass over the suprarenal gland and unite with each other. Below the kidney the layers remain separated, the space being traversed by the ureter, and are finally lost in the iliac region. Thus it may be seen that the renal fascia forms a tube which in the female resembles a cone with apex above. This is due to the relatively increased breadth of the pelvis and the narrowness of the lower costal margin acquired in some cases. In the male the lower chest has a greater width and the breadth of the pelvis is shorter, the renal fossae have a distinct pear shape with the narrower portion below.

Fig. 5A. Fig. 5B.

Fig. 5A and B. Mrs. M. Two pyelograms taken in prone (A) and upright (B) postures illustrating degree of left dystopia.

In position the kidneys lie opposite the last thoracic and the first two lumbar vertebrae. The lower pole of the right kidney is about ½ inch above the level of the umbilicus, the left about one inch above. The upper pole of the right kidney reaches to about the inferior border of the eleventh rib, while the left is at the superior border. The right kidney has further attachments consisting of folds of peritoneum extending from the liver, the hepatorenal ligament, and from the duodenum, the duodenal ligament. The left kidney is further supported by similar structures, the leinorenal ligament from

the spleen, and one of lesser importance from the pancreas, consisting of subperitoneal tissue. Both receive further support from the diaphragm, the phrenicorenal ligaments.

Fig 6A. Fig. 6B.

Fig. 6A and B. E. B. Two pyelograms taken in prone (A) and upright (B) postures illustrating bilateral dystopia and hydronephrosis.

Longyear[2] described a connective tissue band which he calls the nephrocolic ligament, extending from the colon to the lower pole of the kidney. He contends that nephroptosis is secondary to a coloptosis and is due to the pull of the colon on the ligament which displaces the kidney. It has been demonstrated, however, that this structure does not exist in the normal healthy individual.

Thus it may be seen that the kidney depends upon several factors for its normal position. They are in order of their importance.

1. The renal pedicle.
2. The renal fascia.
3. The fatty capsule.
4. Intra-abdominal pressure.
5. The various peritoneal and subperitoneal attachments just described.

Kidd[3] lists four body types found with renal dystopia:

Type 1: Those individuals with lax abdominal muscles.

Type 2: Cases with compression of the hypochondrium.

Type 3: The ectopic or unascended kidney of the congenital type.

Type 4: The type with the narrow flat chest and narrow abdomen with good abdominal muscles and a weak nervous system, which he calls the "Egyptian" type.

We are not so much concerned with Type 2 in this country in the present generation, and Type 3 cannot be considered since renal dystopia is acquired. We can agree with Types 1 and 4 and as many other types as may be mentioned

because we do not believe that body type influences renal ptosis. It has been stated that long thin-chested individuals with sharp costovertebral angles are more prone to dystopia than are short thick-set people. As will be seen from the illustrations practically all body types are represented.

Wolkow and Delitzin[4] believed body form to be a factor in dystopia and evolved a formula of mensuration in which they divided the distance from the sternal notch to the symphysis by the circumference of the abdomen and multiplied by one hundred. If the result was 77 or over, the individual was considered to have dystopia; if the result was 73 or less dystopia did not exist.

Harris[5] of Chicago confirmed these findings. Southam[6] believes man to be predisposed to dystopia because of the erect position. In quadrupeds the kidneys are supported on the horizontal layer of renal fascia which acts as a hammock.

Lenhoff[7] states that patients with movable kidney were found to have a distinct contraction or diminution in the capacity of the middle zone of the body. Sinkler[8] believes the most common cause of dystopia to be the loss of perirenal fat.

Women are particularly prone to renal dystopia because as they approach maturity the pelvis broadens, the pelvic outlet becomes larger, and the funnel of renal fascia even wider at its base than before. Post partum the intra-abdominal pressure is lessened due to the laxity of the muscles of the abdominal wall and perineum. The fatty capsule and other fat deposits are diminished allowing the trabeculae to sag. Assuming arduous duties too soon after parturition, before muscular tone has been restored, and the use of improperly fitting

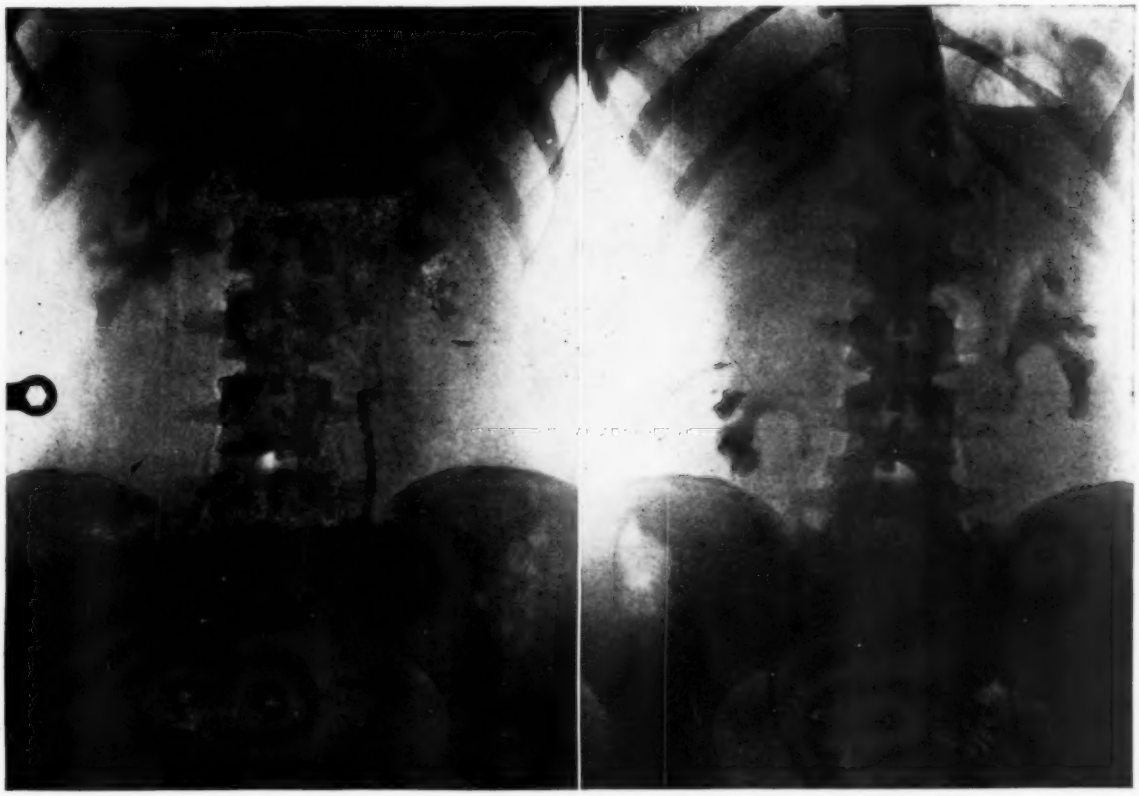

Fig. 6c. Fig. 6d.

Fig. 6c and d. R. K. Two pyelograms illustrating bilateral dystopia and kinked right ureter.

supports or none at all tend to increase the motility of the organ. Congenital anomalies of the pedicle and other attachments are responsible in many instances for increasing the symptoms. Aberrant vessels distorting the course of the ureter, decreasing its lumen and obstructing the flow of urine add to the symptoms. Repeated body jars, as may be sustained by certain occupations or forms of exercise, may constitute sufficient trauma to gradually increase renal motility. Harris[5] states that movable kidney does not occur suddenly as a result of a single trauma except in cases of predisposing body type. Mathe[9] believes that severe injuries seldom are followed by movable kidney; as a matter of fact the kidneys are more firmly fixed than ever, and that a single injury never results in dystopia. Movable kidney requires time to develop. Albarran[10] thinks movable kidney is in reality a body stigmata of degeneracy and therefore is dependent upon congenital predisposition.

Bell[11] believes that congenital constitutional tendencies are the etiological factors in the majority of cases. He does not believe that pregnancy influences dystopia. In his series of 300 cases, 50 per cent of the women were nulliparous or unmarried.

Fig. 7A. Fig. 7B.

Fig. 7A and B. B. A. Right dystopia.

In our series 40, or only 13.3 per cent, were unmarried, and while this does not disprove Bell's statement we are rather inclined to believe that the urinary stasis resulting from the mechanical obstruction produced by pregnancy is certainly a large contributory factor to the various complaints associated with dystopia.

The right kidney is more frequently involved than the left. This may be accounted for by the longer renal pedicle, and the fact that violent respiratory activities are transmitted to the right kidney directly by the solid liver and the

fact that the anterior renal fascia on the right is weaker than on the left.

The diagnosis of dystopia cannot be properly made without the aid of pyelograms in two postures. It has been our practice to do simultaneous bilateral pyeloureterograms under fluoroscopic control as has been described by one of us (H.L.M.[12]). Many operators advise against this practice, but under fluoroscopic control the exact location of the catheter tip is definitely determined. It should be just within the ureteropelvic junction. The injection then of opaque medium does not produce spasm. The degree of filling of the pelvis may easily be determined. The catheter may then be withdrawn and the medium deposited along the lumen of the ureter, care being exercised not to overdistend in any one place by too rapid injection. Exposure is made with the patient prone. The table is then raised to the vertical position, the patient standing on a platform fixed to the table. We prefer to have the patient standing on his feet as we do not believe we get a true interpretation of the degree of renal motility with the patient in a sitting position. The necessity of a motor-driven fluoroscopic table for the correct diagnosis of dystopia is readily seen. The degree of dystopia, the presence of rotation, the relative course of the ureters may then readily be visualized. A grooved holder on the under side of the fluoroscopic screen accommodating an 8 by 10 inch cassette enables us to record any particular pathology. A third exposure is routinely

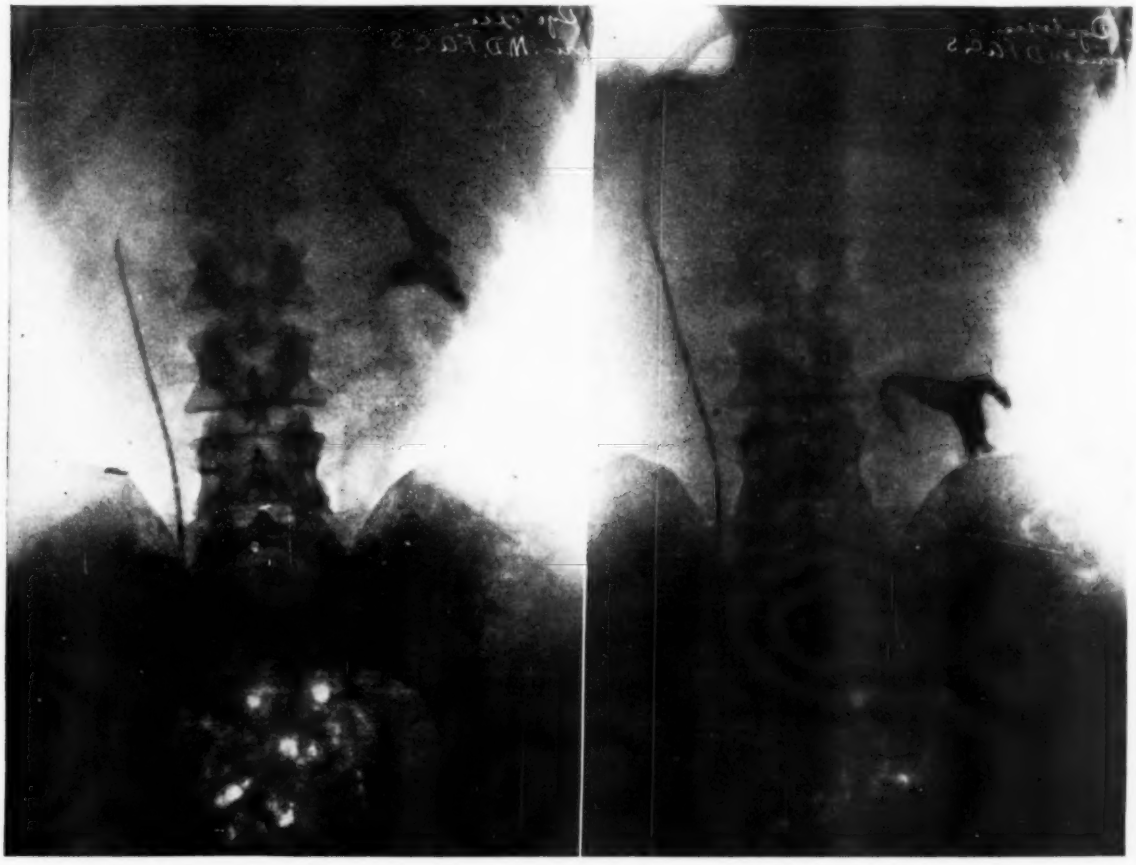

Fig. 7c. Fig. 7d.

Fig. 7c and d. M. G. Right dystopia and tortuous ureter.

made ten to fifteen minutes later to determine the retention of pyelographic media, indicating the degree of urinary stasis.

pain. The distribution of this pain occurred 42 times in the right lumbar region as compared to 27 times in the left, while 41

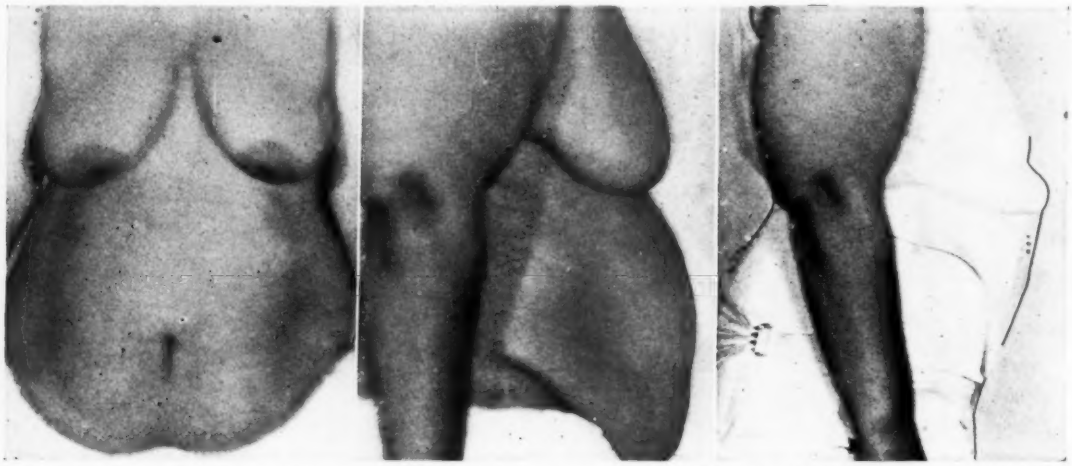

FIG. 8. Views of trunk, front, lateral and with belt adjusted. Age, fifty-six. Height 5 ft. 4 in. Weight 208 lb. Circumference measurements: Umbilicus 40½ in. Trochanteric 49½ in. Distance between costal margin and crest of ileum 4 in. Distance from ensiform to pubes 16 in. Bilateral dystopia 1¾ in. Bifid pelves, grade two. Relief on wearing belt.

In this series there were 299 females and 44 males, or in a ratio of 6 to 1. The youngest was a girl of fifteen years and the oldest seventy-five years of age. Most of the women were in the childbearing age, 115 cases occurring in patients between the ages of twenty-six and thirty-five inclusive. The number of cases decreased as the age increased, although 14 patients were seen whose ages were between sixty-one and sixty-five. In the male patients findings were similar. Twenty-six of the 44 were between the ages of twenty-six and thirty-five. This was undoubtedly due to the fact that men up to this age indulge in more strenuous exercise and harder work than after this period. The accompanying chart (Fig. 1) shows graphically the ages and number of cases occurring in each group. In seven the age was not stated.

The predominating local symptoms were those of urinary tract infection and stasis. Two hundred and twenty-two complained of frequency; 173 of smarting and burning; 79 of urgency; 82 of chills and fever. Backache occurred in 179. One hundred and seventeen patients complained of

patients complained of bilateral lumbar pain. This group is separate from those complaining of backache. Fifty-six patients had distinct renal colic as first described by Dietl. Eight complained of abdominal pain. Hematuria occurred in 61 cases, which was due to pyelitis or ureteritis, as only one of this group was diagnosed as calculus. Constipation as a general complaint was rather common as would be expected in this class of patient, occurring in 114 instances.

Headache, nausea and vomiting are shown on the chart (Fig. 2) not so much in connection with the urinary tract complaints as in the general group indicating toxemia, for certainly dystopia and the resultant stasis in the majority of cases is not confined to the urinary tract alone.

Bell states that in addition to the direct symptoms there are the reflex symptoms due to the autonomic nervous system. The kidney pulling on its pedicle irritates its nerve, the trauma is transmitted to the proximal ganglion which in turn affects the whole sympathetic system which might easily be responsible for

causing functional changes in any viscus supplied by the system. This may explain the variety of symptoms manifest in this

On urological examination 28 were found to be suffering with right renal dystopia and one with right renal calculus. Sixty

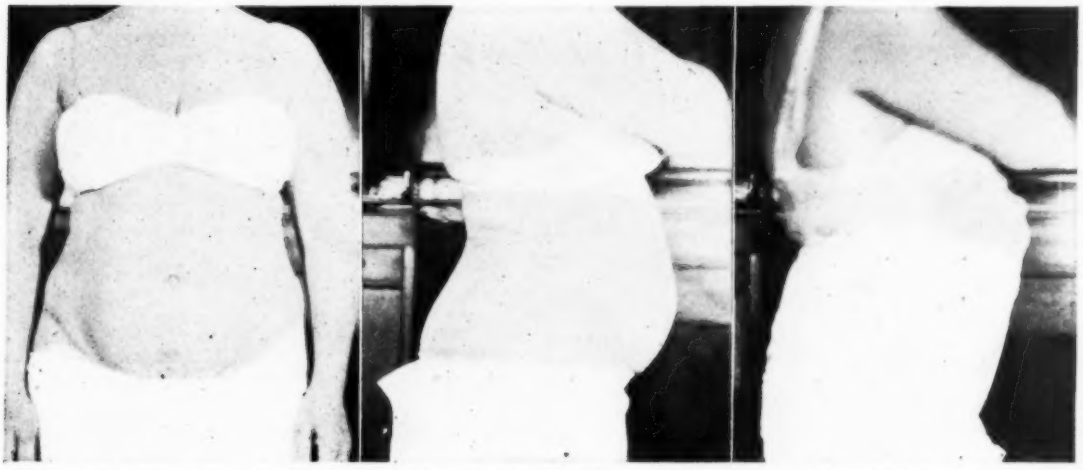

Fig. 9. Mrs. J. Views of trunk: front, lateral and with belt adjusted. Age, twenty-five. Height 5 ft. 1 in. Weight 151 lb. Circumference measurements: Umbilicus 38 in. Trochanteric 40 in. Distance between costal margin and crest of ileum 2 in. Distance from ensiform to pubes ¼ in.]

disorder. He also explains the pelvic complaints by stating that pressure on the ovarian vein by a sagging kidney is responsible for ovarian congestion. The various nervous and hysterical manifestations which are generally conceded to accompany this condition were not noticeable in this group.

The cystoscopic findings (Fig. 3) were those of cystitis alone. Two hundred and eighty two cases were found to have infected urines: staphylococcus in 145; colon bacillus in 137. Ureteral obstruction occurred in 35 cases.

The pyelographic findings are shown in the table for convenience:

	Left	Right
Hydronephrosis	39	84
Blunted calices	33	72
Pelvic retention	9	15
Aberrant vessel	11	17
Hydroureter	37	57
Tortuous ureter	51	71
Dystopia	18	113
Dystopia—bilateral	212	

It was interesting to note in this regard that 97 patients had had previous appendectomies performed; 29 of these patients still complained of their symptoms.

patients had had pelvic operations, e.g. hysterectomy, oophorectomy, salpingectomy, and uterine suspension. Twelve of these still complained of their symptoms; further examination revealed the cause to be dystopia. Twenty per cent were evidently subjected to the risk and discomfort of a major operation without sufficient evidence to warrant the treatment. Two out of 12 operated on for gallbladder disease still had persistent symptoms not relieved by operation and were found to have dystopia. In each case the correction of the dystopia plus the routine treatment of urinary infection resulted in relief of the discomfort.

The intermittent urinary stasis in dystopia resulting from ureteral obstruction over a long period of time with subsequent dilatation of the renal pelvis and flattening of the papillae predisposes to infection, calculus formation, and other urinary tract pathology, and is responsible for various degrees of pain. The disturbance of the sympathetic nervous system caused by irritation from tugging at the renal pedicle undoubtedly is responsible for various complaints which might

easily be attributed to other organs. Sturmdorff[13] in a recent publication dealing with pelvic disorders totally ignores renal dystopia as a causative factor in backache, and Bullard[14] states in his analysis of backache that "in fifteen cases out of every hundred the backache persisted after otherwise successful correction of gynopathic conditions." It has been observed in our series that 169 patients had previous operative procedures, and it already has been noted that 32 of these, or 20 per cent, still complained of their symptoms. It seems significant how nearly this figure coincides with that of Bullard. These patients on investigation were found to have dystopia. We think it is safe therefore to assume that from 15 to 20 per cent of all cases of backache are due to renal dystopia.

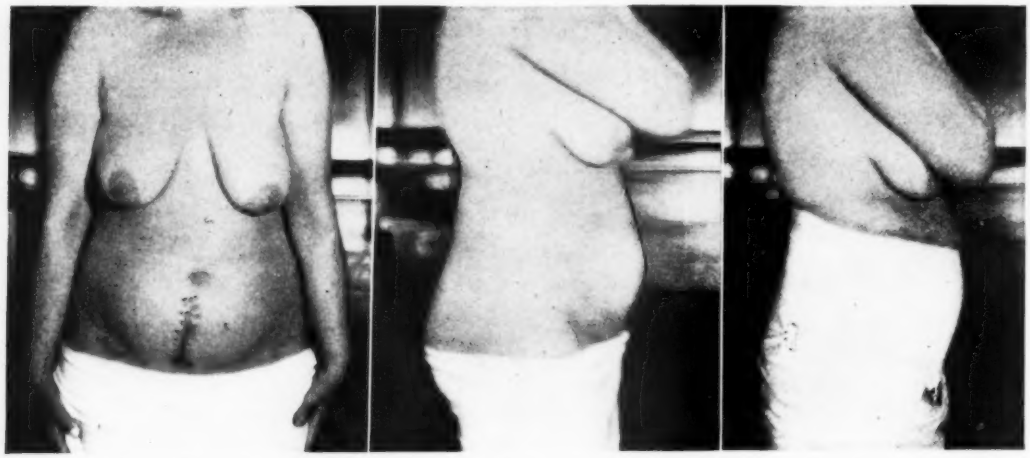

Fig. 10. Mrs. K. Views of trunk: front, lateral and with belt adjusted. Age, twenty-three. Height 5 ft. 2 in. Weight 123 lb. Circumference measurements: Umbilicus 38 in. Trochanteric 33 in. Distance between costal margin and crest of ileum 2½ in. Distance from ensiform to pubes 14 in. Bilateral renal dystopia, with grade two pelves. Marked relief on wearing belt.

Hess[15] reports the success of renal sympathectomy for the nephralgia accompanying floating kidney. He states that these patients are relieved of their pain and gastrointestinal symptoms; that denervated kidneys produce about one-fifth more urine than their unoperated fellow organs; that the urine from a denervated kidney is but of slightly less specific gravity, and that there is more propulsive force to the ureteral jets of urine. He further states that denervated kidneys are just as efficient as normal kidneys under stress.

The term nephralgia aptly describes the backache characteristic of renal dystopia.

Since the advent of pyelography the diagnosis of renal dystopia should rarely be confounded with tumor of the colon, enlarged spleen, gallbladder disturbances, enlarged lobe of the liver or pelvic disorders. The colic of renal calculus disease may also be differentiated from Dietl's crisis by the use of the *x*-ray. Suspected chronic appendicitis deserves the precaution of a urological examination to rule out the possibility of renal dystopia.

TREATMENT

Hahn of Berlin in 1851 performed the first nephropexy; Weir, 1882, was the first in America. Bell states that the method of choice in the treatment of dystopia is nephropexy, as does Billington[16] in his recent publication on movable kidney.

Mathe states: "Surgical suspension has fallen into disrepute, not on account of inefficiency, but because it has been performed when it has not been indicated. The technique has been faulty or there has been failure to realize the necessity of exposing the ureter and relieving any

condition which might be present, which unrelieved would defeat the purpose of the operation." Lowsley[17] used belts in his cases, and if after trial these fail to produce the desired result, nephropexy is performed. Kretschmer[18] employs the same procedure. Braasch[19] states that there were only 23 cases in which nephropexy alone was performed at the Mayo Clinic. Young says: "The ultimate results of nephropexy have proved less favorable in cases followed for a long time, and the other forms of treatment have shown better results when faithfully carried out." Elam[20] believes that "uncomplicated cases are certainly operative as nephropexy will unquestionably relieve the symptoms produced by a ptosed and movable kidney, and may even admit of reaction of a kidney in which structural changes are beginning."

The uniform success of a proper support, properly applied, with the addition of symptomatic treatment of urinary infection and stasis, has led us to believe that nephropexy should be employed only as a last resort in the treatment of uncomplicated ptosis, but if the kidney cannot be placed in its normal bed; if there are adhesions or other anatomical changes which prevent its return, surgical correction is indicated.

It is absolutely essential that the belt be properly fitted and that it be applied while the patient is recumbent. The use of kidney pads should be discouraged because the excessive pressure produced by a pad over a small area is not only uncomfortable, but its continued use lessens circulation and causes muscular atrophy at that site. Patients after long-continued use of trusses illustrate this point. If a patient is careless in applying such a support and the pad occurs above the kidney the dystopia is increased. A properly made belt should be back laced, quickly and easily adjusted, be made of duck or other non-elastic material and should not employ a pad. It should extend from just below the gluteal fold to the second or third lumbar vertebra behind. In front it should extend from the lower border of the symphysis to the umbilicus, but not above. Such a belt has several advantages beside correcting dystopia. It relieves symptoms. It is comfortable and improves the figure. Too much importance should not be attached to the opinion that support tends to decrease muscle tone. The majority of women employ the use of some type of abdominal support; why not one with some therapeutic value?

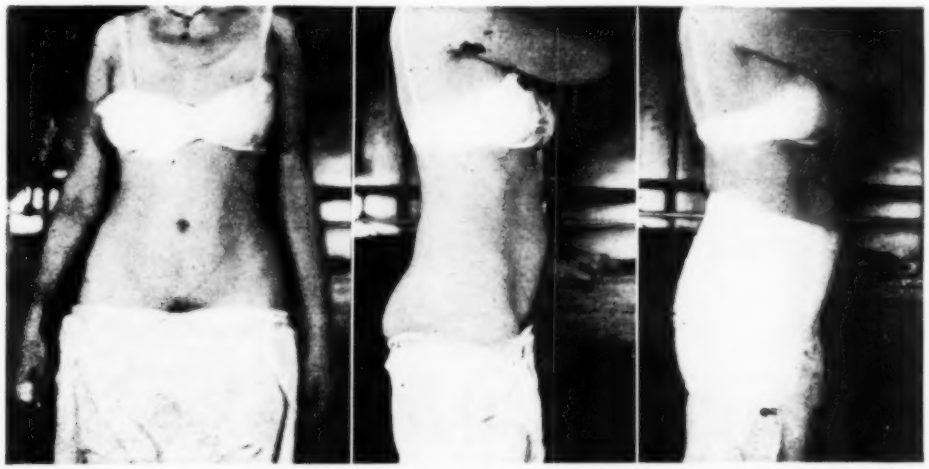

Fig. 11. Mrs. L. Views of the trunk: front, lateral and with belt adjusted. Age, twenty-four. Height 5 ft. 6¼ in. Weight 113½ lb. Circumference measurements: Umbilicus 28½ in. Trochanteric 38 in. Distance between costal margin and crest of ileum 4 in. Distance between ensiform and pubes 12½ in. Egyptian type. Right dystopia with small hydronephrosis. Left normal.

The value of diet is questionable in the treatment of dystopia, except as a general measure. The addition of weight will not materially assist in the correction of dystopia, neither will rich diet meet with the approval of an already overweight individual.

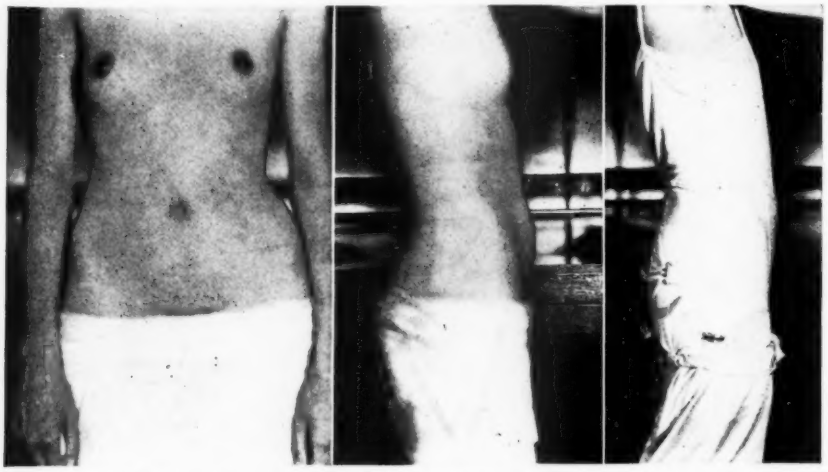

Fig. 12. Miss B. Views of trunk: front, lateral and with belt adjusted. Age, twenty-two. Height 5 ft. 7¼ in. Weight 104¾ lb. Circumference measurements: Umbilicus 36 in. Trochanteric 34 in. Distance between costal margin and crest of ileum 3 in. Distance from ensiform to pubes 14 in. Right scoliosis. Bilateral dystopia. Both pelves grade two.

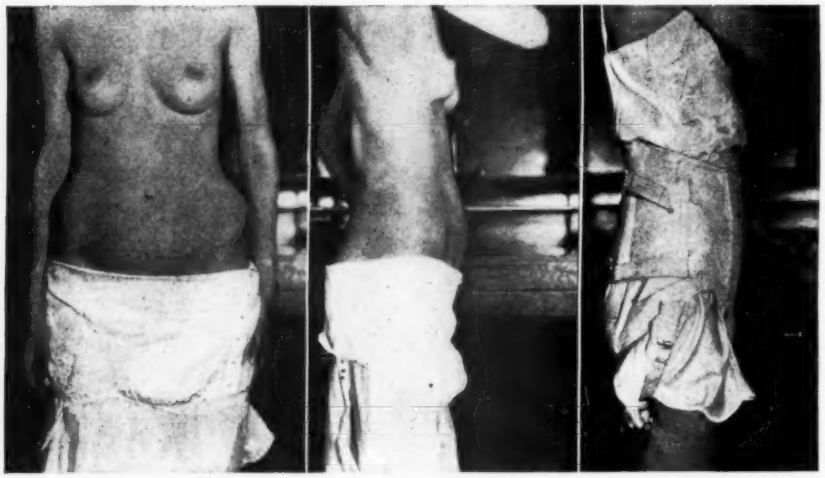

Fig. 13. Miss B. Views of trunk: front, lateral and with belt adjusted. Age, forty-two. Height 5 ft. 9 in. Weight 107 lb. Circumference measurements: Umbilicus 33 in. Trochanteric 26 in. Distance between costal margin and crest of ileum 3 in. Distance between ensiform and pubes 12 in. Note the marked disproportion between trunk and iliac crests which necessitated accurate fitting of belt. Bilateral dystopia.

In this series, 202 patients were treated with belts, ureteral dilatation and pelvic lavage. Of these, 152, or 75 per cent, were relieved of their symptoms and required no further treatment. One hundred and seventy-five patients received no form of treatment other than belts and of these 146, or 92 per cent, state that they have been cured. Only 6 cases of uncomplicated renal dystopia, or 1.7 per cent, had nephropexy performed. All other operative procedures were performed for co-existing complications which demanded surgery and should not be classed as nephropexy.

Although most any operative procedure involving the kidneys is more or less

responsible for the firmer fixation of these organs, as any one can testify who has had occasion to expose a previously operated kidney. Care should therefore be exercised to return a kidney to its proper bed before closure, to ensure proper drainage of urine.

A brief abstract of the six nephropexies follows.

Case I. Mrs. M. S., No. 138, aged twenty-one, married, one pregnancy. Reported January 7, 1924, complaining of backache and loss of weight. Right kidney palpable, both renal areas tender to fist percussion. On cystoscopy both urines were found concentrated and contained many specks. Phenolsulphonpthalein test revealed some damage to right kidney function. Right culture grew staphylococcus. Bladder urine grew B. coli. Pyeloureterograms showed the right pelvis to be Grade 2. Considerable stasis was noted, the pelvis remaining full after thirty minutes. Dystopia of 2 inches was noted on right side and a diagnosis of aberrant renal vessel was made. She was supplied with a belt and treated symptomatically until symptom free. Patient reported four years later, having been comfortable in the meantime. She then gave a history of exposure to cold and wet, followed two weeks later by right renal pain. Examination revealed much the same pathology as before noted. Patient was fitted with a belt. *X*-ray with belt in place showed kidneys held in normal position. She had no further complaints until April 4, 1929. Following a long motor trip she complained of a constant, severe backache, bilateral. She was fitted with a new belt and was given pelvic lavages. Following this she was comfortable until January 11, 1930, at which time pyelograms showed a small beginning hydronephrosis and s-shaped kink on the right side. Nephropexy was advised. Accordingly she was operated upon March 14, 1930 under spinal anesthesia. When last seen, August 29, 1930, the urines were clear from both kidneys, the patient was comfortable and had no urinary complaints.

Case II. Miss M. H., No. 1685, aged seventeen, single, no pregnancies. Reported May 24, 1927. She had been complaining of constant right renal pain, which one year previously had become so severe that she was hospitalized. It was diagnosed appendicitis and she was operated on without relief of symptoms. The right kidney was palpable, the lower pole very tender, and there was very pronounced tenderness along the course of the right ureter. A pyelogram revealed a right-angled turn laterally to the border of the psoas muscle and another right-angled turn at the ureteropelvic junction on the left side. The right ureter was dilated and had an s-shaped kink. There was a dystopia of $2\frac{3}{4}$ inches on that side. Two different types of abdominal support were tried but without success. She was admitted to the hospital October 27, 1927. A right nephropexy and sympathectomy was done October 28, 1927. Recovery was uneventful and she was discharged November 18, 1927. She was last seen January 19, 1928, with no urinary complaints. Urine was clear and sterile.

Case III. Mrs. C. P., No. 1415, forty, married, para six. Reported August 27, 1926, complaining of frequency, burning and smarting, urgency, backache, headaches, for the past year. She had definite tenderness over both ureters, especially the left. Cystoscopy showed a mild generalized cystitis, left ureterocele, and trigonitis. Urines at this time showed many pus cells and B. coli. Pyelograms in the upright position showed the left kidney to be at the crest of the ileum, the right below the crest of the ileum. Patient was fitted with a belt and given pelvic lavage. She was then comfortable until February 26, 1927, when she reported complaining of right renal pain. Right kidney urine was turbid and contained pus. The belt was readjusted and on *x*-ray examination apparently allowed no abnormal renal excursion. She next reported January 29, 1929 wearing a corset not designed to correct dystopia. She had been complaining for the past two months of right renal backache and bladder symptoms. Right kidney urine at this time was turbid and contained red blood cells. She was advised regarding support and in the event it proved unsatisfactory to have surgical correction. The patient was carried along on symptomatic treatment until October 2, 1930, when she had a right nephropexy performed. She made a good recovery, was discharged November 21, 1930, with incision healed and no urinary complaints.

Case IV. Mr. E. B., No. 1790, aged thirty-eight, factory worker. Reported September 30, 1927, complaining of severe pain in the right renal region. Pyelogram showed a Grade 2 right pelvis and a dystopia of 1½ inches with a sharply angulated ureteropelvic junction. He was supplied with a belt and treated with pelvic lavage until April 7, 1928, at which time pyelogram showed an increase in the size of the right renal pelvis, calices more blunted and a dystopia of 2 inches, and the ureter more tortuous. He was admitted to the hospital and on April 12, 1928 a right nephropexy was done. Adhesions were found in the middle third of the ureter which prevented the return of the kidney to its normal bed. Recovery was uneventful; discharged April 28, 1928. He was last seen February 7, 1930. There were no urinary complaints.

Case V. Mrs. F. R., No. 1817, aged thirty-seven, factory worker. Admitted to clinic September 20, 1927, complaining of pain in right hypochondrium, dull, nagging in character, referred to the region of the right shoulder blade, and of one year's duration. Pyelogram showed right kidney to be rotated, the pelvis was considerably dilated, moderate hydronephrosis and some dystopia. She was admitted to the hospital and on October 7, 1927, a right sympathectomy and nephropexy were done. Recovery was uneventful and she was discharged from the hospital October 21, 1927, with wound healed, patient feeling comfortable. *X*-rays taken December 14, 1927 showed the kidneys in normal position with a motility of 1¼ inches.

Case VI. Mrs. M. M., No. 2163, aged thirty-three years, married, no pregnancies, housewife. Reported August 9, 1928. Complained of right lumbar pain of more than one year's duration, smarting and burning, and headaches. She had had an appendectomy performed one year previously with no relief of symptoms. On examination she had a palpable tender mass in the right side of the abdomen. Tenderness extended along the course of the right ureter. On cystoscopy the right ureter was catheterized to a point about midway, where an obstruction was encountered, which could not be overcome. Pyelograms revealed a right renal dystopia of 2¾ inches with resultant tortuosities of the ureter. She was supplied with an abdominal support. *X*-rays taken October 12, 1928, with support in place showed no correction of ptosis. She was admitted to the hospital and on October 25, 1928, a nephropexy was done. Recovery was uneventful. She was discharged November 12, 1928. *X*-ray taken December 7, 1928, showed normal motility of the right kidney.

The foregoing abstracts show the importance of frequent and thorough examination of these patients. They are prone to become careless in applying their supports, need readjustments and occasionally active treatment to control their infection.

CONCLUSIONS

After careful consideration we feel justified in arriving at the following conclusions:

1. These findings are the results obtained from a study of 343 cases of renal dystopia.
2. Body type does not influence renal dystopia.
3. The predominating symptoms of renal dystopia are those of urinary infection, stasis and backache, aptly termed nephralgia.
4. Fifteen to 20 per cent of all cases of backache are due to renal dystopia.
5. The proper diagnosis and interpretation of *x*-ray films are dependent upon the method of procedure.
6. In the great majority of cases of renal dystopia satisfactorily fitting belts, properly applied, plus routine treatment for urinary infection, have given complete relief of symptoms.
7. Nephropexy is seldom indicated in the treatment of renal dystopia.

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[For Remainder of References see p. 433.]

A CASE OF

CAVERNOUS HEMANGIOMA OF THE BLADDER*

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HEMANGIOMA of the bladder is probably the rarest of all neoplasms of the bladder. Assisted by the Librarian of the American College of Surgeons, 16 cases of hemangioma have been found in the literature. The first mention of such growths is that of Gross in his treatise on the urinary organs, 1851. A soft, cauliflower-like tumor was found, at autopsy, in the bladder of a woman aged seventy-two. No histological description is given. The first authentic case appears to be that of Langhams, who is credited by Clado as having found a hemangioma, in 1879, at necropsy of a boy, aged nineteen, who had died of hematuria. The largest part of it was on the posterior vesical wall, where the mucosal and submucosal layers were composed of cavernous tissue.

Albarran, in 1892, observed a hemangioma at necropsy of a man aged sixty-four, who had died following operation by Guyon. The patient had suffered from hematuria. The tumor was submucosal and the bladder epithelium was well preserved. Histological examination showed capillary dilatation surrounded by connective tissue.

At the Clinical Society in London, 1895, Lane reported a case of extensive degenerating nevus of the bladder in a child, aged three and one-half years. Two years before admission to the hospital the child commenced to pass bloody urine, at times large flat clots; occasionally there was profuse hemorrhage. Scattered about the anus and buttocks were a few small patches of degenerated nevoid tissue and their presence led to the diagnosis that the bladder condition was also nevoid. The mass in the bladder could be felt distinctly both above the pubes and by the rectum.

FIG. 1. Hemangioma of bladder. Rule above is in inches.

Suprapubic cystotomy was done and large angiomatous masses protruded through the incision. Almost all of the mucous membrane was involved. Excision seemed inadvisable. For some unexplained reason the child's condition improved greatly after the operation. The final outcome is not recorded.

Jungano, in 1907, described a massive cauliflower angioma, in the region of the trigone, undergoing sarcomatous degeneration in a man aged fifty-four years.

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Bryan reported, in 1909, a typical cavernous angioma which was removed by suprapubic cystotomy.

Fig. 2. Photomicrograph of hemangioma of bladder.

Judd and Harrington reported, in 1918, a case of angioma in a woman, nineteen years of age, who had complained of incontinence for two years. The tumor was the size of a large grapefruit. The bladder was greatly hypertrophied and there was an area in the right anterior wall of the bladder through which the growth extended into the right extravesical space. The pathological diagnosis was papillary angioma.

Launay, Achard and Carriere saw, in 1920, an angioma of the right bladder wall. The tumor was composed of two parts; one part, globular and very hard, was composed of connective tissue in which blood vessels were dilated and filled with blood; the other part was soft and the connective tissue was infiltrated with small blood clots.

Scholl, in 1920, reported, from the Mayo Clinic, three patients with tumors of the bladder which were classed angiomata:

Case 1. A girl, aged nineteen, had had pus and blood in the urine and mild incontinence for two years. At operation a large polypoid tumor was found filling an enormous bladder. The tumor extended into the prevesical space through an area about 3 cm. in diameter. A slight recurrence three months later was successfully fulgurated and five years later the bladder was normal.

The tumor was firm and contained many blood cysts and sacculations, but the largest part of the growth was composed of interlacing blood vessels supported by connective tissue.

Case II. A man, aged seventy-six, had had occasional moderate hematuria for eight months. An inoperable sessile growth, covered with papillomatous excrescences, was found on the left base of the bladder. The growth was extensively fulgurated but seventeen months later the symptoms returned. There was a widespread mass covering the entire left half of the bladder and involving the prostate and posterior urethra.

Case III. Girl, aged seven, with slight hematuria which had persisted for six years. Some blood had passed by rectum. A mass, 6 cm. in diameter, was palpated in the region of the bladder. Death followed severe rectal hemorrhage. Necropsy revealed an extensive cavernous angioma growing from the base of the bladder and invading the rectal mucosa.

Rafin, in 1920, saw a diffuse angioma in the bladder of a girl, aged seventeen, who had recurrent hematuria from the age of four years. Cystoscopy showed the trigone, interureteral zone and ureteral orifices were normal. The remainder of the bladder presented two aspects; one was characterized by small red grains separated from each other by exceedingly distinct small, white spaces. A few islands of normal tissue were interspersed. In other regions there were large bluish blood vessels and islands circumscribed by the same bluish color, with a moderate degree of projection. Some of these were about to ulcerate. The general aspect was that of a diffuse nevus, not involving the entire surface. Surgical intervention was avoided because of the diffuse character of the angioma.

Faeber, in 1922, observed in a girl, aged eleven, who began to have hematuria when five years of age, a case of hemangioma of the bladder. The bleeding recurred at intervals but there was no pain at this nor during the succeeding five years. Cystoscopy showed a large hemangioma of the bladder. The growth was removed partly by excision and partly by Paquelin cauterization.

Kidd, in 1923, reported an angioma of the bladder removed at operation. The patient, a man aged twenty-nine, had developed acute retention two years previously. The tumor was smooth, pedunculated, and looked like a red raspberry, although about the size of a date.

Caulk, in 1925, reported a small hemangioma of the bladder wall which had the appearance of an ordinary nevus. The small, bluish, bleeding elevation was destroyed by fulguration.

Caulk also reported in the same article a pulsating cavernous hemangioma of the ureter, simulating inoperable carcinoma of the bladder. He was unable to find in the literature a single case of hemangioma of the ureter.

Marion, Huber, Okazaki, and Katz each have reported a case of cavernous angioma.

While somewhat irrelevant in the present discussion, it seems of interest to note that hemangioma of the kidney is about as rare as it is of the bladder, and very difficult to diagnose. The presence of hemangioma of the kidney should be suspected when all other possible lesions are ruled out and when the onset of renal bleeding is sudden and severe. Mackey, in 1930, reviewed the literature. He was able to find only 17 cases of hemangioma of the kidney in addition to one which he reported. Since this time Bailey has reported one other case.

CASE REPORT

White male, aged twenty-seven. The family history and the past history are irrelevant, except the urinary symptoms. The physical examination was practically negative except that a large mass could be felt in the bladder.

Present Illness. Father states that the patient had the first attack of frequent, painful and bloody urination at the age of six months. These attacks recurred from time to time and lasted usually five or six days, but occasionally for two or three weeks, the longest was five weeks. Until the patient was eleven years of age these attacks came on once a month or oftener; after that the time between the attacks was from one to five years. The patient had a very severe hemorrhage in 1929 and was confined to bed for twelve days. His parents had been told that he had an incurable cancer.

In spite of repeated hemorrhages, the blood count and hemoglobin were essentially negative. Upon admission to the hospital the patient complained of a feeling of fulness and pain in the region of the left kidney and ureter. A uroselectan picture showed the ureter and pelvis to be slightly dilated.

Cystoscopy showed a tumor about the size of an orange, no pedicle could be seen. Part of the surface of the growth was covered with closely set cysts about the size of split peas. These cysts were of many colors; most of them were greenish yellow. There were occasional bleeding points. The cystoscopy picture was not that of papilloma or carcinoma. Different parts of the tumor, however, looked quite different. The diagnosis of angioma was not suspected, either from the cystoscopic appearance or from inspection of the gross specimen when removed. The left ureteral orifice was elevated by the tumor but showed normal squirts of indigo carmine; the right ureteral opening was normal.

Operation. Through a transverse suprapubic incision, the peritoneum was separated from the bladder and the vesical wall was incised. In shape and size the growth and its short pedicle greatly resembled a door knob. After excision, the bladder was closed and drained in the usual manner. The patient made an uneventful recovery and has had no return of bleeding or painful symptoms. The pain and fulness in the left kidney region did not reappear after the operation. He has agreed to return from time to time for cystoscopic observation and fulguration, if required for recurrences. The pathologist reported the tumor to be cavernous hemangioma.

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* Continued from page 368.

INSULIN IN OBLITERATIVE LESIONS OF THE BLOOD VESSELS*

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SINCE the isolation of insulin by Banting and Best in 1921 its uses as a regulator of carbohydrate metabolism, especially in diabetes and as a stimulator of certain nutritive processes, have been well established. Mothersill states that evidence is accumulating to show that insulin, or one of its component parts, is antagonistic to epinephrin, which is a constrictor of certain arterioles; in other words it is a vasodilator.

Some of the cases I have to report seem to raise the question as to whether these three activities of insulin adequately explain the results obtained. I would suggest that the property of fat consumption also operates.

My opportunities have been confined entirely to general country practice. During the past three years it has been my good fortune to see several cases presenting unusual features and each giving a hint for the use of insulin in new fields. I have no desire and am not qualified to argue pathology; but I would simply suggest a theory based on two accepted facts, which to me explains with some satisfaction the following cases. Stated first are the two facts, then the theory, followed by case reports.

1. Virchow proved many years ago that fat occurs in the intima of arterioles in sclerotic conditions. And Mallory, in his last work on "Pathologic Histology," states:

> The presence of fat in the different cells forming the walls of blood vessels is the best guide we have as evidence that the functional activity of the lining is interfered with, owing to injury of some sort or other. If later the cells undergo necrosis the fat is set free and becomes a prominent feature in the lesions formed because *its removal requires much time.* In fact the reaction to the fat, at least in the intima, forms the most conspicuous feature in many lesions, especially those of a chronic type. Under toxic and other unfavorable conditions fat may collect in the lining endothelial cells, in the muscle cells, or in the fibroblasts. Fat is also commonly associated with the more serious lesions of blood vessels, such as the hyaline change often present in the arteries of the spleen in diphtheria for example, and necrosis from various causes.

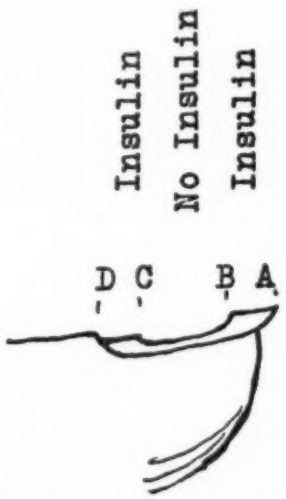

FIG. 1. A–B. Portion of nail grown while insulin was first taken. B–C. Nail growth during absence of insulin treatment. C–D. Nail growth since July, 1931, when use of insulin was resumed.

Joslin, in the chapter on Arteriosclerosis of his treatise, "Treatment of Diabetes Mellitus," discusses blood fat and cholesterol as a cause. He notes that fat in the form of cholesterol esters is deposited in the vessel walls by imbibition from the blood, these walls having no means of absorption, and that the more fat in the blood the more readily it would be deposited.

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Note: What a list of maladies this brief reference suggests: arteriosclerotic disease of the brain, the eye, the kidney, the aorta, the extremities, and how many others?

2. The second accepted fact is one established a few years ago: that insulin burns some fat in the "flame of carbohydrate combustion."

Serious consequences arise in a number of diseases because fat-laden cells gradually narrow and finally occlude completely the terminal vessels, as in atherosclerotic gangrene whether diabetic or not, in angina pectoris, in chronic nephritis.

The theory suggested is that insulin, given to a patient with any malady in which the terminal vessels are becoming occluded, in addition to digesting carbohydrates, stimulating nutrition, and dilating certain arterioles, may furnish relief by the burning of fat-laden cells in the flame which consumes blood sugar, thus allowing the blood stream to flow where it was stagnant or arrested.

Little can be expected of insulin in dealing with fibrous tissue or calcareous deposits. If a vessel lumen is gradually narrowed by a degenerative process the scar tissue and the calcareous deposits are only very slowly affected by any treatment. It is only the final plugging of the already almost completely obliterated vessel by fat-laden or degenerated cells that concerns us here. The only contention is that a very small lumen may be opened or maintained when, without insulin, no continuance of function could be possible. If insulin be used before stasis occurs much more may be expected.

I have seen insulin apparently help the following conditions:

1. Atherosclerosis, in both diabetics and non-diabetics.
2. Angina pectoris.
3. Bed sores in old people.
4. Deep and extensive leg ulcers.
5. Chronic nephritis.
6. Thromboangiitis obliterans.

These cases form a group in which terminal vessels are involved, with fat occupying a prominent place in the pathology. If the theory has a reasonable foundation no apology is needed for presenting so diversified a list of reports.

CASE REPORTS

Case I. *Diabetes with Atherosclerosis.* J. H., male, aged sixty-three, laborer.

This patient lost his right leg above the knee by amputation on account of gangrene which started in the great toe.

In September, 1928, Mr. H. had an infected ingrowing nail of the left great toe. The nail was very thin, the nutrition was defective. The infected area about the nail was a dirty gray color, gangrene threatened. Insulin was being administered three times daily. Weeks were required to secure healing, and when it was complete, it was noted that the new nail above the matrix, which had grown while the insulin was being given, was better nourished. It was thicker, whiter and flatter than the previous growth.

Just here I got my impression that the insulin affected the nutrition of the nail profoundly in addition to digesting carbohydrates. The improved growth of the nail was an index to the improved circulation of the whole foot and body. (This was three years ago.)

After several months, diet alone controlled the glycosuria and the insulin was omitted; but when, in July, 1931, the importance of insulin in maintaining nutrition in non-diabetic atherosclerotics was impressed on me by Case III, I prescribed a small dose for Mr. H. to be taken twice each week.

At the present time the record of the insulin on the growth of the nail is very clearly indicated, as shown in the accompanying sketch (Fig. 1).

During the absence of insulin the nail is thinner and contracted.

Case II. *Diabetic Gangrene Right Foot.* Miss C. N., aged seventy-seven.

When gangrenous area appeared in dorsum and plantar surfaces of foot, it was found that this patient was a diabetic.

Insulin was prescribed and the diet regulated. Four months passed before the foot healed; and by that time the same trophic change was noted in the nails that had characterized the first case.

Diet alone controls the glycosuria, but the patient receives a dose of 5 units of insulin

once weekly in an effort to maintain the function of a damaged peripheral circulation.

Case III. *Non-diabetic Threatened Gangrene Atherosclerosis.* M. V. S., male, aged sixty-three, fisherman. In November, 1930, the right foot was purple and swollen with complete stasis of the circulation.

On account of impressions received from Cases I and II, it was decided to see what insulin would do in this non-diabetic. Ten units were given; the foot was elevated and kept warm. Within twenty-four hours the swelling was gone and the foot was pink. Subsequent treatment consisted of 5 units of insulin given once per week.

The improvement in the growth of the toe-nails in this case has been more marked than in the diabetics.

As this paper is being prepared, this patient has been returned to the hospital for the removal of two bones of the great toe instead of the leg above the knee as was advised a year gao. At operation, three ligatures wers required to control bleeding, and there wae also free capillary oozing from the cut surface. On account of the abundance of blood supply to the soft parts, the wound was closed with stitches instead of being left open to granulate.

Case IV. *Angina Pectoris.* Miss M. C., aged seventy-seven.

Non-diabetic. Cardiac hypertrophy. Three valves involved in chronic endocarditis.

The first attack of angina occurred in 1925; the second a year later; succeeding attacks becoming more frequent and severe. During the past year this patient moved only with pain, and required assistance dressing, retiring and rising.

For three years preceding June, 1931, this patient received treatment with iodides and nitrites, of the latter taking as many as twelve in a day. On June 29, 1931, a severe attack of angina required a hypodermic of morphia. (Comment: It was in the presence of this apparent calamity that the similarity of the pathology of the vascular system of the heart in angina to the pathology of the purple feet in threatened gangrene presented itself; insulin seemed to ask for a trial.) Beginning with a dose of 5 units of insulin, a total of 40 units was given over a period of a month, no dose exceeding 8 units. Orange juice or sugar followed one-half hour after each dose.

At the end of this period the patient was walking about at will, without assistance. The relief from pain is marked.

Note: In treating angina with insulin it must be borne in mind that the path to travel is very narrow; Joslin reminds us of the danger of a hypoglycemia to a weak heart muscle. One must be sure that the blood sugar level is sufficiently high. From experience with cases of precordial pain in the aged, in which the myocardium was involved and which were relieved entirely by doses of iletin as small as 3 units, I believe the doses of 8, or even 5, in the case here cited was unnecessarily large.

It should not be expected that insulin will relieve an acute attack of angina; but, given once or twice per week, it has been my experience that the attacks will be prevented.

Case V. *Bed Sores in the Aged.* T. P. S., male, aged eighty-seven, veteran of Civil War. As a result of a fall on June 12, the neck of the left femur was fractured. On account of atherosclerosis and long confinement in bed and a lack of cooperation on the part of the patient in relieving pressure, a gangrenous area developed at the heel and along the outer aspect of the left foot. The heel area of gangrene was 1¾ inches long and 1¼ inches wide; around this and extending outward was a pink area of lowered resistance and slowed circulation.

On September 21, 5 units of insulin were given. Within forty-eight hours the pink discoloration was gone and was replaced by normal-looking skin. A second dose of 5 units was given on the twenty-third. On October 1 the entire gangrenous slough had separated, leaving a healthy granulating surface. On October 16, 5 units were again given, at this time the granulating surface had healed to the size of a dime; and on October 25 there was a tiny red spot remaining. Since insulin has been used no attempt has been made to relieve pressure, but healing has gone on as in a young healthy person.

It should be stated that during the last six weeks the patient has been out of bed several hours each day, thus relieving pressure.

Case vi. *Deep and Extensive Leg Ulcers.* J. H. K., male, aged fifty-one, farmer. After a slight injury, an ulcer appeared on the calf of the right leg, in August, 1929. Septicemia developed in November of the same year. He was unable to walk for nine weeks, or to put his foot to the floor. June 1, 1931, the right leg was swollen to twice its normal size. It was discolored and the superficial layer of skin was moist and rubbed off with slight friction, leaving a red, oozing surface. In the calf of the leg was a deep crater-like ulcer measuring 6 inches across, and covered with a layer of gray granulations. No progress has been made toward healing since a serious illness in 1929.

Insulin was begun on June 1, 1931, and given once per week in a dose of 5 units. Beginning October 20, 5 units were given daily.

October 26, the size of the leg was normal. The granulating surface was level with the surrounding skin, and a strip of epithelium had grown entirely across the original area leaving two healing surfaces, each less than a half-dollar in size.

Case vii. *Chronic Nephritis.* Mrs. M. G., aged thirty-two, white, housewife. This patient had mumps in early childhood; typhoid fever at six. There have been four pregnancies: the first normal with normal delivery in September, 1921; the second was terminated by cesarian section at seven months on account of bleeding from partially detached placenta, the cause not determined; the third was a normal pregnancy and delivery with good recovery; the fourth was terminated by curettage on account of the present condition of nephritis at six weeks.

After the third pregnancy the patient's health was good. When nephritis developed cannot be determined. It was discovered at an examination made March 11, 1930, at which time the symptoms would indicate that it had been present for some time. The chief complaint was of headaches; the blood pressure was 148/108.

There was double parotitis. Amount of urine: 2000 c.c. per day; light in color, clear, sp. gr. 1.012; acid; a dense cloud of albumin when boiled; no sugar. Microscopically much epithelium from whole urinary tract; clumps of amorphous urates; coarse granular casts and an occasional hyalin cast.

The parotitis yielded shortly to Basham's mixture. The headaches persisted and occurred at shorter intervals in spite of diet regulation, which for a year has been limited to milk.

October 17, 1931: For several months the patient says she has had severe headaches at the vertex, averaging three per week and lasting about eighteen hours. On this date the headache was more severe than usual. The patient's color was poor, pale and gray; the eyelids were edematous.

Five units of insulin were given in the late afternoon. The patient says the headache was gone in less than two hours. There was no recurrence up to October 25. A second dose had been given on the twentieth, and it is proposed to repeat this once or twice weekly as indicated.

Examination of the urine shows a diminished amount of albumin. The same total quantity was passed in twenty-four hours.

December 1, 1931: Since October 25th the patient has appeared once in seven to nine days for her insulin. She has been free from headaches and her general appearance is improved.

Comment: Here we have a sclerotic terminal blood vessel condition similar to that in threatened gangrene and apparently a similar effect is produced by the iletin in both conditions: an improved blood supply to the part affected with improved function and diminished toxemia.

Case viii. *Buerger's Disease: Thromboangiitis Obliterans.* In order to readily understand this case it may be stated that early in July, 1931, after observing the case of angina, a paper discussing the first four cases was prepared and read at the July meeting of the Staff of the Cape Cod Hospital. Copies of this paper were sent to a medical journal and to certain individuals high in the medical profession. One copy was forwarded to Prof. E. J. G. B.; the latter on September 1, 1931, advised as follows:

"Dr. Beale: Today I have heard from the patient with Buerger's disease for whom you were kind enough to suggest insulin. I enclose the letter of his physician, Dr. E. A. B." This letter, which follows, furnishes the record of Case viii, Mr. H.

"I have waited for results to reply to your very kind letter of July 22nd, suggesting the use of insulin in H's case.

"At the time your letter was received he was becoming rather desperate, running a temperature of 103.5 (ax) and with distended abdomen and delirium; all I could think of was internal gangrene and death. I immediately began the use of insulin continuing K. I. and M. S. (reducing the latter to ⅛ A.M. and ¼ P.M.) and he began promptly to improve and is still improving.

"His mind has entirely cleared, temperature continues normal, pain lessened and occasionally he walks down stairs to a meal. Of course he has lost considerably in weight. There is less postural discoloration of both hands and feet which was becoming more and more marked. He has his days of depression but in general his mental attitude is very good. He has recently developed a mitral murmur, but all in all he is an entirely changed man since insulin has been given.

"We are grateful to you for the suggestion which was so timely and so helpful . . . " F. B. A., M.D., August 31, 1931.

I wish to add here the following comment from one of the profession of high standing:

Anything that *may* work is well worthy of trial in these most painful and crippling disorders and if they relieve pain to any degree we have, I think, no right to deprive a patient of that amount of relief even if we have no very good reason for thinking that we know *how* the good is done.

A further report from this case of Buerger's disease states that the torturing pain common in the later stages of this disease has appeared. If the pathology of this stage is borne in mind, the stage in which nerve, vein and artery and adjacent tissues are bound together and compressed by contracting scar tissue, little can be expected of insulin. It will be interesting to find what may be done if early diagnosis is made and insulin given from the outset.

Since submitting this article we have had 2 cases of acute obliterative enderitis at the Cape Cod Hospital in which the curative effect of insulin was demonstrated. Working with Dr. Elmer Robbins, Jr., we have secured very definite curative results with insulin in a case of chronic glaucoma complicated by chronic iritis. A case of vertigo in an elderly man, which I believe was due to sclerosis of the vessels of the middle ear, has remained free from symptoms for eight months following treatment with small doses of insulin.

A SIMPLIFIED POSTOPERATIVE ROUTINE FOR THE DIABETIC PATIENT*

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DIABETES mellitus is a disease which, after passing through several medical phases, now has added a surgical aspect to its field of activity. Prior to the discovery of insulin it almost invariably terminated fatally, death being usually caused by diabetic coma. Now insulin tends to prevent acidosis, which is the initial stage of coma, and it is the sequelae of diabetes, or rather the associated pathologic conditions, which are causing death in the diabetic patient, chiefly arteriosclerosis, with its harmful effects on the cardiovascular-renal system, and gangrene of the extremities, with the possibility of septicemia. The pathology of the cardiovascular-renal system is still a purely medical consideration, but the beginning gangrene of the extremities, the slow, progressive ulceration of the toe or foot, have come under the care of the surgeon. These facts are fully comprehended, and an increasingly large number of diabetic patients are being cared for on surgical services today, but only a few surgeons have taken the time or made the effort to train themselves to care for the diabetic patient in any but his surgical aspect; their first appeal is for an internist to treat the diabetes, while they concern themselves only with the necessary surgery.

That the surgery of diabetes has a dual aspect is a fact that permits of no argument, and Joslin, in particular, has well stated the importance of the relation between the medical and surgical sides. Unless the diabetes is fully controlled before any surgery is undertaken, the patient is exposed to the risk of a stormy convalescence and to the possibility of an aggravation of his diabetes, since insulin materially loses its effectiveness in the presence of infection. On the other hand, more than one writer has emphasized the fact that diabetes can actually become an asset to a patient because of the critical and painstaking care he receives preoperatively and postoperatively. In addition, as Saunders of Cornell has recently pointed out, the well cared for diabetic is seldom a candidate for surgery as a direct sequel of his disease: a hundred public ward patients require emergency surgery to every one private patient, a situation which furnishes convincing evidence of the value of proper medical care.

The usual method of handling the surgical diabetic is to provide him with separate medical and surgical care, but this dual method of therapeusis has many obvious disadvantages. It by no means follows that because a patient is receiving twice the amount of care, he is receiving twice as effective care; as a matter of fact, he is often receiving less effective care because of the divided responsibility. The internist usually prescribes entirely for the control of the diabetes, and perhaps never sees the surgical lesion postoperatively, or, if he does see it, does not recognize its full importance. On the other hand, the surgeon usually takes it for granted that the diabetes is well under control, and regards only the local lesion as his responsibility. Perfect cooperation would obviate these mischances, it is quite true, but perfect cooperation is frequently an ideal, not a fact, and with the best will in the world on the parts of all concerned, it is often not achieved. Would it not be simpler, therefore, especially on a large surgical ward, to have a routine standing treatment for all surgical diabetics, drawn

* Submitted for publication October 13, 1931.

up by the internist and supervised by him, but carried out by the surgical house staff under the direction of the surgical attendant? With such a plan in effect, the surgeon is able to judge more accurately the relation of the diabetes to the surgical wound, as well as the effect of the local disease upon the diabetes.

A routine of this kind has been in operation for a considerable period of time on Surgical Division A of St. Luke's Hospital in New York City, and I venture to present it here because my experience with it as Surgical House Officer at that institution convinced me of its safety and its practical advantages. The routine was devised by Dr. James R. Scott, Associate Attending Physician at St. Luke's, and I take this opportunity of acknowledging my indebtedness to him for the patient and painstaking instruction which he gave me in this method of treatment.

The preoperative control of the diabetes is, of course, a purely medical matter and is handled on the medical ward. The criteria of safety for surgery are a normal blood sugar for several consecutive days (three to six) prior to operation, and an immediate preoperative urine free from sugar, acetone or diacetic acid. The patient is transferred to the surgical service the evening before operation, and the routine of preparation differs from the usual routine in just one respect: two hours before operation the diabetic patient is given 6 oz. of orange juice by mouth and 10 units of insulin by hypodermic, this being a ratio of 1 unit of insulin to every 1.8 gm. of carbohydrate.

Operation can usually be done under gas and oxygen anesthesia, supplemented by a preliminary hypodermic of morphine. Ether is to be avoided because the diabetic does not tolerate it well.

The postoperative orders differ from the usual orders only in two respects, that the urine is examined at regular intervals, and that a special diet is instituted. The urine is examined at three-hour intervals for sugar, acetone and diacetic acid, even if the patient has to be catheterized to secure the specimen. Five cubic centimeters of Benedict's solution are boiled for five minutes, preferably in a water bath, with 8 drops of urine, and the resulting specimen is checked against the table given below, insulin being administered according to the findings.

Color of Urine	Per Cent Sugar in Urine	Units Insulin
Blue	0	Orange juice 6 oz.
Green	Less than 1	5 units
Orange	1 to 5	10 units
Red	5 to 10	15 units

The color scale is posted in a conspicuous place in the laboratory, and is made from ordinary crayons. The colors are taken from the colors obtained by boiling 1, 5 and 10 per cent glucose solutions with 5 c.c. of the Benedict reagent, and the order, naturally, is similar to the order in the spectrum. This color test, simple as it is, is perfectly accurate, for the colors have been checked and are within the range of the corresponding sugar percentages, and it can therefore be safely substituted for the more complicated sugar quantitative analyses; it is checked at intervals, of course, by blood sugar estimations. Moreover, it is practically error-proof for the administration of insulin.

Until the patient is able to eat a semi-soft diet, which is usually at the evening meal on the first day, nourishment must be given in the form of sugar, best administered orally as orange juice. If nausea is a feature, 6 oz. of a 10 per cent glucose solution can be given rectally, and if oral and rectal feedings are both impossible, intravenous glucose therapy can be resorted to. As a rule, however, the oral administration of orange juice is possible, and by the evening meal on the first day the patient can be given test diet No. 1, as shown on the diet card which is appended.

Unless the diabetes is shown by repeated urinalyses to be under absolute control, the three-hour urine examinations are continued throughout the first night, with the exception of the three A.M. test, which may be omitted if the patient must be awakened to secure the specimen. A specimen of blood is taken on the second morning for a sugar estimation. By this time the patient's condition is usually such that the test diet No. 1 can be divided into three meals a day, and the urinalyses can be reduced to four daily, one specimen being taken over night and one after each meal. Subsequently the blood sugar estimations need be made only every second or third day. Gradually the diet can be built up to one of the maintenance diets or to the diet given previous to operation, insulin being administered as necessary to keep the blood sugar normal and the urine sugar-free.

In the occasional case in which the urinalyses during the first twenty-four hours show that the patient has a tendency to acidosis and in which the blood sugar continues irregular, an emergency diet may be resorted to: orange juice and buttermilk, 6 oz. each, are given alternately every two hours for a total of eight feedings. This diet approximates 600 calories daily, and since it is palatable to the majority of patients, it can be continued over four or five days if necessary. The three-hour urine specimens must also be continued over this period, and blood sugar estimations must be made daily. When the diabetes is controlled, the patient can be put on test diet No. 1, and subsequently on one of the regular maintenance diets.

In any case in which the diabetes is not absolutely controlled postoperatively, prompt consultation is had with the internist who makes daily ward rounds in a supervisory capacity. Our experience at St. Luke's, however, is that such consultations are rarely indicated, for the reason that the frequent checks upon the patient's condition make the control of his diabetes a relatively simple matter and prevent the development of unforeseen complications.

Personally, after my service as house officer on a surgical ward in which this routine was followed rigidly, I am convinced of the many advantages it offers. It requires no elaborate laboratory equipment, and so it can be used quite as well by the patient himself in his home after discharge as by the staff in the hospital. It is absolutely safe, because the three-hour urinalyses and the frequent blood sugar estimations ensure at all times full knowledge of the patient's condition. It provides for the individualization of each patient, because both diet and insulin are regulated according to his individual needs, as shown by accurate laboratory findings, and are not administered according to a fixed scale. It substitutes for the usual rather cumbersome dual control of surgeon and internist a single control which is particularly valuable when an emergency arises and special treatment is demanded without delay. And finally, as I have already pointed out, its success is proved beyond question by the results which have followed its employment on a large surgical service, and which have been almost invariably good.

Note. An illustration of the special sheet used for diabetic cases, which sets forth the progress of an uncomplicated test case, is herewith appended, as is one of the St. Luke's diet cards. Both the special sheet and the diet card will be found very convenient and helpful.

ROUTINE DIABETIC DIETS

St. Luke's Hospital

1931

"B. & O." diet*.....	C 122	P 21	F 7	Calories 635
Test diet #1.....	C 130	P 65	F 30	Calories 1050
Maintenance diet #1.	C 140	P 70	F 50	Calories 1290
Maintenance diet #2.	C 150	P 75	F 110	Calories 1890
Maintenance diet #3.	C 170	P 85	F 125	Calories 2145
Maintenance diet #4.	C 200	P 90	F 125	Calories 2510

ST. LUKE'S HOSPITAL
New York City

Ward_____
Name_____ Age_____

Date	Urine 24 Hrs., Cc.	Total Output Fluid	Fluid Intake Mouth	Total Fluid Intake	HT. / WT.	Food: COH	Food: Prot.	Food: Fat	Food: Total Calories	Urine: Sp. Gr.	Urine: Reaction	Urine: Alb.	Urine: Ferric Chloride	Urine: Nitro-Prusside	Urine: Sugar %	Urine: Color	Blood: Sugar	Blood: Urea	Blood: CO_2 Vol. %	Miscellaneous: Total N	Miscellaneous: N of Food	Miscellaneous: Glucose Available	Miscellaneous: Glucose Utilized	Units Iletin	Urine Microscopic Remarks
1/1	6 A.M.	Mai	nten N	ance o.	diet 3	170	85	125	2145	..	..	..	o	o	o	Blue	188	14.8	52	..	..	..	..	..	
	9 A.M.	..	..	..	..	...	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	10	20 units 1/1
	1 P.M.	..	..	..	..	...	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	..	
	7 P.M.	..	..	..	..	...	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	10	
1/2	6 A.M.	..	..	..	..	...	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	..	
	7 A.M.	..	..	..	..	6 ℥ jui	Or ce	ang	e	..	..	..	....	..	....	.....	...	....	..	..	..	..	..	10	
	9 A.M.	Ope	ratio	n		..	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	..	
	Noon	..	..	..	..	6 ℥ jui	Or ce	ang	e	..	..	..	+	++	o	Blue		....	..	..	..	..	..	10	
	3 P.M.	..	..	..	..	...	..	...	....	..	..	..	+	+	3%	Orange	...	....	..	..	..	..	..	10	45 units 1/2
	6 P.M.	Sup	per N	Test o. 1	Diet	130	65	30	1050	..	..	..	+	+	2%	Orange	...	....	....	..	..	..	..	10	
	9 P.M.	..	..	..	..	...	..	...	....	..	..	..	o	+	0.8%	Green	...	....	..	..	..	..	..	5	
	Mid-night	..	..	..	..	0 ℥ jui	Or ce	ang	e	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	..	
1/3	6 A.M.	Bre	akfa	st		...	..	...	....	..	..	..	o	+	o	Blue	164	15	46	..	..	..	..	10	
	9 A.M.	..	..	..	..	...	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	..	
	Noon	Lun	ch			...	..	...	....	..	..	..	..	..	....	.....	...	....	..	..	..	..	..	..	15 units 1/3
	1 P.M.	..	..	..	..	...	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	..	
	6 P.M.	Sup	per			...	..	...	....	..	..	..	..	..	....	.....	...	....	..	..	..	..	..	5	
	7 P.M.	..	..	..	..	...	..	...	....	..	..	..	o	o	o	Blue	...	....	..	..	..	..	..	..	
1/4	6 A.M.	Mai	nten N	ance o. 3	Diet	170	85	125	2145	..	..	..	o	o	o	Blue	170	14.4	54	..	..	..	..	10	Adjust insulin to diet.

METASTATIC PULMONARY CARCINOMA*

ROBERT C. PENDERGRASS, M.D.

AMERICUS, GA.

IN every case of carcinoma the dread specter of metastasis haunts us. The early recognition of the spread of cancer may prevent futile operations, enable us to alleviate suffering and prolong life, and give us a more accurate basis for prognosis, that thing about which we tell the family much and the cancer patient little. It is the object of this paper to call attention to one phase of metastasis, namely, lung involvement, and to illustrate the roentgen findings in this condition. The discussion will be limited to carcinomatous metastases of the lungs, and will deal more particularly with metastases from carcinoma of the breast.

In carcinoma of the breast, the chief sites of metastasis are lymphatics, skin, bones and lungs. Metastasis may occur elsewhere, but less frequently. As a rule, those cases showing lung metastases do not show bone metastases, and vice versa, but we will present an exception to this rule. Among other primary carcinomas which metastasize to the lung are those of the thyroid, adrenals, prostate, testicle, and rarely the stomach, esophagus, and cervix.

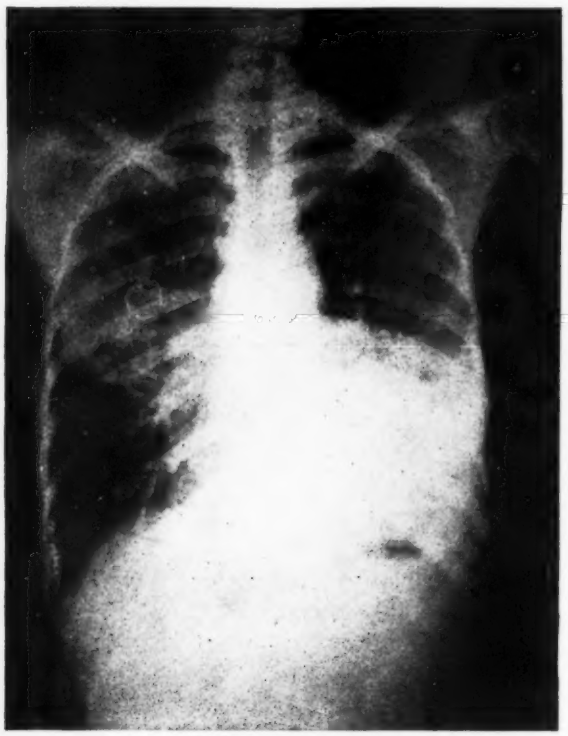

FIG. 1. Case 1. Infiltrative and massive types of metastases. Note circular area of calcification over right breast, shown by breast films to be in breast tumor.

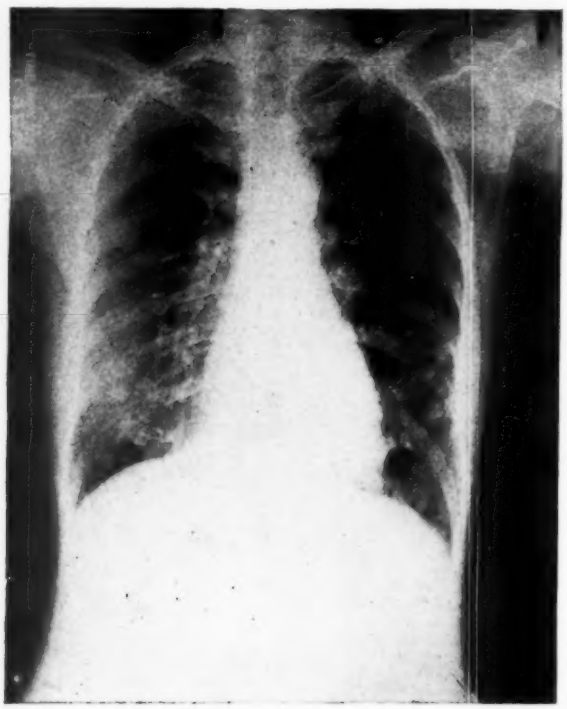

FIG. 2. Case 11. Combined nodular and infiltrative types. More nodules on left, more infiltration on right.

CLINICAL SYMPTOMS AND FINDINGS

The clinical symptoms of metastatic pulmonary carcinoma are usually meager, indefinite and unreliable. Pain is probably the earliest suspicious symptom, and is

* From The Wise, Smith and Anderson Clinic. Read before The Medical Association of Georgia, May 15, 1931.

usually due to pleural involvement. Cough occurs fairly early. Fever may be absent or slight. Hemoptysis and dyspnea are usually late symptoms. Sweats may occur at any stage, usually late. If effusion occurs, then cough, pain and dyspnea are apt to appear early; in large effusions, dysphagia is common, due to pressure on the esophagus.

The physical findings are extremely variable, and depend on whether the hilum glands, parenchyma or pleura is involved. Since more than one type of involvement often occurs in the same chest, we may get râles, dullness, signs of consolidation or of atelectasis, evidence of pleural pathology, tracheal deviation, or signs of effusion. If the miliary and small nodular metastases are present, there may be little variation from the normal; a counterpart of the paucity of physical signs in some cases of miliary tuberculosis. In the infiltrative, consolidation and atelectatic types, more change in breath sounds occurs. The signs of effusion are no different from the signs of effusion due to other causes; they exhibit more tendency to shifting than purulent exudates.

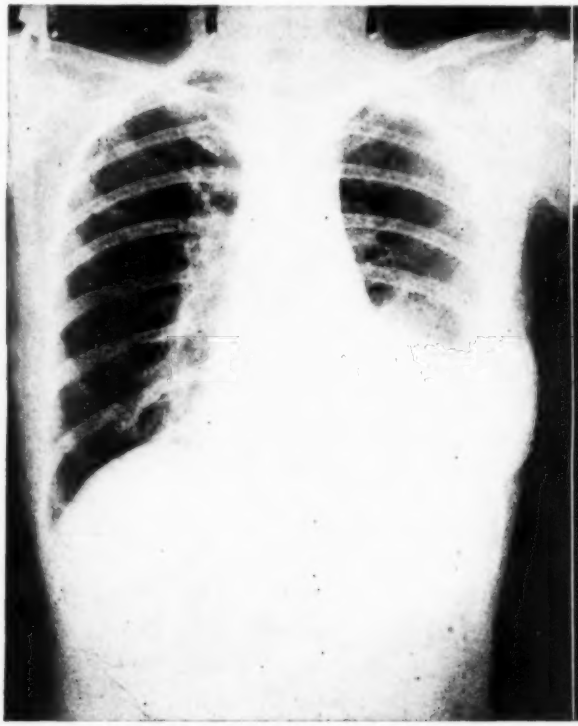

Fig. 3. Case III. Pleural type of involvement, with some consolidation of left lower lobe. Film made after aspiration of large amount of fluid.

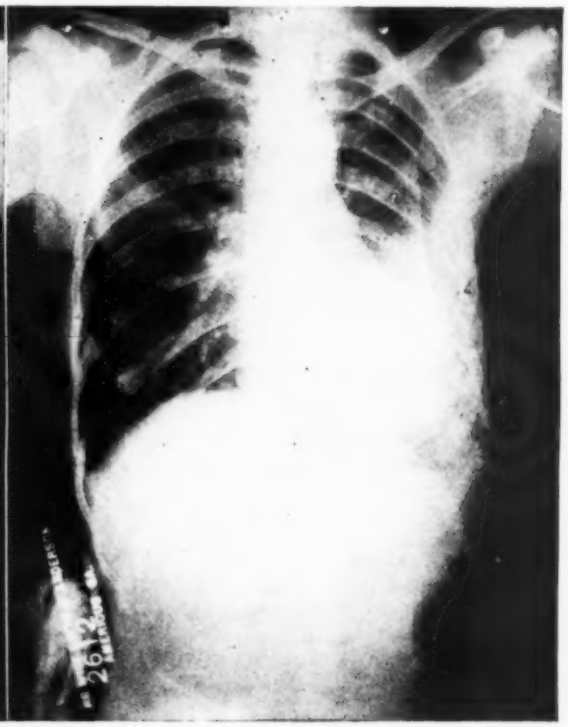

Fig. 4. Case IV. Pleural type of involvement. Inoperable carcinoma of left breast. Example of direct extension to same side as tumor.

ROENTGENOLOGIC DIAGNOSIS

Since the physical findings in pulmonary metastasis are so highly variable, and smack more of confusion than of clarity, it is necessary to evoke the aid of radiology in diagnosis. Every case of primary malignancy elsewhere should be subjected to *x*-ray examination of the chest, for only in this way can lung involvement be detected early and depicted accurately. I do not wish to leave the impression that there is no room for error in the interpretation of the radiographs; this is far from true, but radiography offers the most efficient diagnostic method.[2]

Since *x*-ray shadows are based on pathological changes in the tissues, the classification of metastases from a radiological standpoint follows closely that of the pathologic classification and according to

Farrell[1] may be grouped under the following heads:

1. Metastases to the tracheobronchial lymph nodes, appearing at the hilum and in the upper mediastinum.

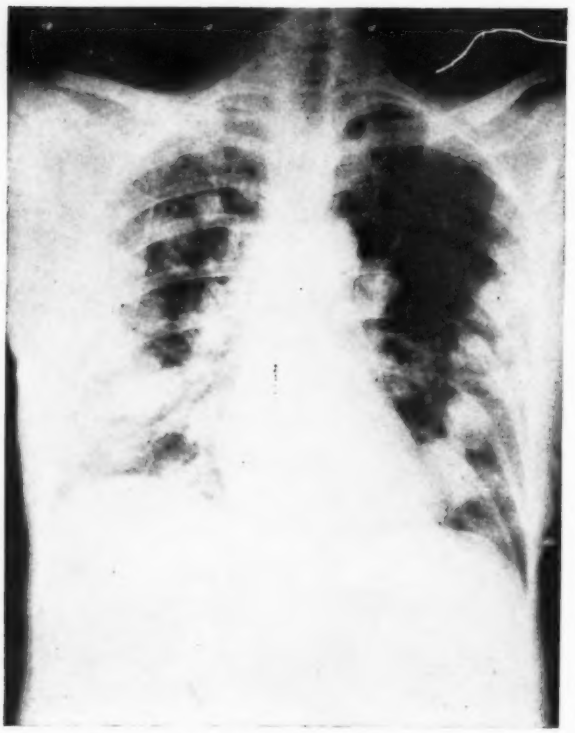

FIG. 5. Case v. Large nodular metastases from carcinoma of cervix.

2. Parenchymal metastases, of four types:

(a) Nodular: small or large nodules, sharply defined, scattered throughout the lung, more prevalent in the lower half.

(b) Miliary: similar to the nodular, but the masses are smaller and more evenly distributed. They may be calcified (Hirsch).[2]

(c) Infiltrative: a radial increase in the markings arising at the lung root; these are prolonged into the parenchyma. Mottling may occur.

(d) Massive: consolidation of all or part of the lobe, and often associated with pleural changes.

The atelectasis of a lobe, due to bronchial obstruction by tumor nodules, should probably be included in this massive type.

3. A third classification (Sante), includes pleural thickening and pleural effusion.

In metastasis from carcinoma of the breast, we may see any or all of these forms. The nodular type of metastasis is most easily recognizable, but may be confused with sarcomatous metastases.[3] The miliary type may be confused with miliary tuberculosis, but the masses in tuberculosis are usually smaller and less sharply defined; the higher pulse rate and temperature and positive sputum in tuberculosis serve to differentiate the two.[3] The infiltrative and massive types are also common, usually associated, and may involve a goodly portion of both lungs. The atelectasis produced by nodules blocking the bronchi, if the atelectatic area is large, may produce distressing pulmonary symptoms, simulating pneumonia on casual examination.

Single large metastatic areas may be confused with primary tumors, as may also hilum lymphatic masses. This is particularly true of the rather uncommon fibroma of the lung, which is usually present as a single rounded mass.[3]

Pleural involvement may occur by direct extension along the lymphatics penetrating the chest wall on the same side as the breast lesion, or may reach the opposite side by a more devious route. In differentiating pleural thickening from effusion, the interspaces are usually narrowed instead of widened, and on diagnostic puncture the thickened pleura is felt, while no fluid is obtained. If effusion is present, the withdrawn fluid is usually blood-tinged. A tendency to rapid reaccumulation is nearly always shown. We have withdrawn a half gallon of such fluid from one side of the chest, only to withdraw the same amount a week later. Primary periosteal tuberculosis of the ribs, secondary sarcoma, and metastases from hypernephroma may resemble carcinomatous metastases of the pleural type. Pleural thickening may occur from the heat of the cautery used at operation or from heavy radiation.[3]

APPLICATION OF ROENTGEN FINDINGS

Once the diagnosis of pulmonary metastasis is established, what are we going to do about it? If a primary malignancy is already known to exist, we may direct treatment to it and to the lung metastases; if the pulmonary metastases are found first, we have received a tip as to the presence of primary malignancy elsewhere, and should search for it.

All types except the pleural effusion type should receive *x*-ray therapy of the chest; one may succeed in relieving pain and cough, and in prolonging life. Too vigorous treatment will make these patients sicker and perhaps shorten life. Partial erythema doses at fairly long intervals seem to have better effect than massive doses applied within a few days. In some cases the nodular masses will become smaller, and even disappear for a time.[3]

If effusion is present, repeated withdrawal of the fluid is perhaps the only method of treatment. Reinjection of equal amounts of air, as suggested recently by Dana[4] in the treatment of empyema may be of benefit. We have used this method in one case. Very little shock or coughing occurs when this method is used. The temporary relief from pain and dyspnea afforded these patients is ample reward for our labors, and compensation for our disappointments in others.

The chief value of the detection of pulmonary metastases is akin to that of the detection of bone metastases, the prevention of futile operations. It may determine whether we shall employ surgery with radiation or radiation alone. Every case of primary carcinoma capable of metastasizing to the lungs should have an *x*-ray examination of the chest before operation.

The general practitioner who has to care for the carcinoma patient after the surgeon and radiologist finish with him has on his shoulders the care and responsibility of the patient. It is he who maintains the lookout for metastasis. If, in the intervals between periodic examinations by the operator or radiologist, the patient exhibits pain in the chest or a continued cough, *x*-ray examination of the chest should be made at once. These are the warning signs of pulmonary metastases just as pain is the warning sign of bone metastases. I believe that periodic *x*-ray examinations of the bones and lungs, after operation for carcinoma of the breast, will eventually come to be as much a routine as inspection of the operative scar and palpation of the neighboring lymphatics. As an illustration of the value of *x*-ray examinations, one of our cases had two tiny recurrences in the scar, and a lung full of metastatic nodules with very little cough or pain; another had extensive pulmonary metastases with no local recurrence. Everyone sees examples of this.

CASE REPORTS

Case I. Referred by Dr. J. T. Stukes. Negress, aged thirty-three. Noticed lump in right breast about one year before coming to clinic. This had grown rapidly and was ulcerated. Large, inoperable cauliflower carcinoma of right breast. First seen February 27, 1929. Deep *x*-ray therapy begun then. Failed to return for treatment until June 2, 1930, at which time metastases found throughout both lungs. Persistent cough. Further therapy lessened cough and pain in chest. Died January 1931, two years after first visit and about three years after lump first noticed in breast.

Case II. Referred by Dr. B. T. Wise. White female aged fifty. Amputation left breast, for scirrhous carcinoma, October 20, 1928. Postoperative radiation. Several small nodular recurrences in scar, treated by surgical removal and radiation. On January 3, 1931, complained of some cough and pain under left shoulder. Film showed numerous nodular and linear type metastases in both lungs. Pain and cough greatly relieved by therapy over chest at intervals. Now having pain in hips and back, but films show no metastases.

Case III. Referred by Dr. E. B. Anderson. White female aged thirty-eight. Radical resection right breast, December 30, 1929. Pathological diagnosis: Scirrhous carcinoma. Postoperative therapy at intervals. In February

1931, acute respiratory attack resembling influenza. Large effusion left chest. Film after aspiration shows pleural thickening and some consolidation of lower lobe. Fluid reappeared after repeated withdrawals, 22 qts. in one month. Developed cerebral symptoms, with facial paresis, and died in coma after prolonged illness, on September 1, 1931.

Case IV. Referred by Dr. Chas. A. Greer. Negress aged thirty-two, September 13, 1931. Large, inoperable carcinoma of left breast; involvement of axillary lymphatics. Physical signs of pleural involvement left breast. Film shows pleural thickening, left. Example of direct extension. Given deep *x*-ray therapy; moved, and have lost track of patient, though still living nine months after first seen.

Case V. Referred by Dr. S. P. Wise. White female aged forty-five, November 28, 1930. First seen with complaint of pain in back and fever. Pyelogram right kidney showed only slight hydronephrosis. On this film was noted a metastatic lesion in the fourth lumbar vertebra, and metastases in lower lung fields. Chest film (Fig. 5) shows numerous large metastases. No pulmonary symptoms. Inquiry disclosed grade 3 carcinoma of cervix treated with radium four years previously, and with no evidence of recurrence one year after treatment. Patient died July 1931, about five years after treatment of original lesion with radium and eight months after discovery of metastases.

SUMMARY AND COMMENT

1. Attention is drawn to the subject of carcinomatous metastases to the lungs, and to the unreliability of symptoms and physical signs in the diagnosis of this condition.

2. The pathology and the resultant roentgen findings are discussed.

3. The practical applications of the discovery of pulmonary metastases are stressed.

4. Brief reports of 5 cases, with radiographs, are given.

5. Every case of primary carcinoma, especially carcinoma of the breast, should have a roentgen examination of the chest and skeleton before operation, and periodically after operation.

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STUDIES ON THE EFFECTS OF

SUBTOTAL GASTRIC RESECTION IN THE DOG*

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CHICAGO

THIS study was undertaken to complete a series[1] of observations in dogs on the effect of various gastric operations on the physiology of the stomach and on the occurrence of postoperative jejunal ulcer. We were particularly interested in ascertaining the postoperative effects of the Finsterer[2] type of gastric resection in the dog.

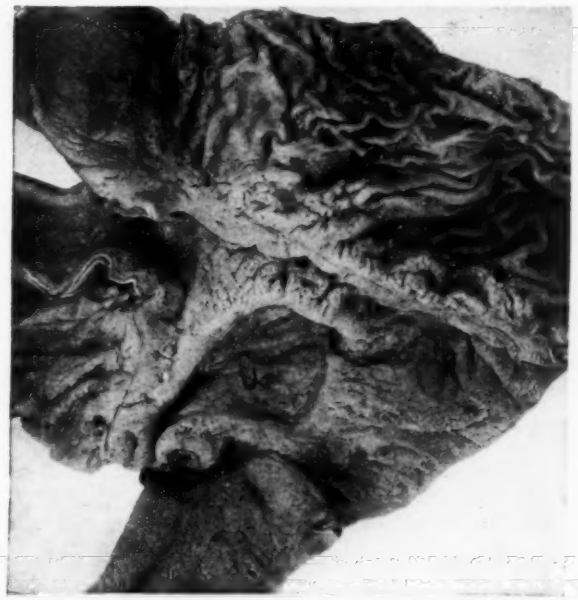

FIG. 1. Jejunal ulcer that occurred in Dog 4. Stomach had hypertrophied to twice original size and jejunum opposite orifice had also hypertrophied to about the same extent. Dog died from hemorrhage from the ulcer at seven months and twenty days.

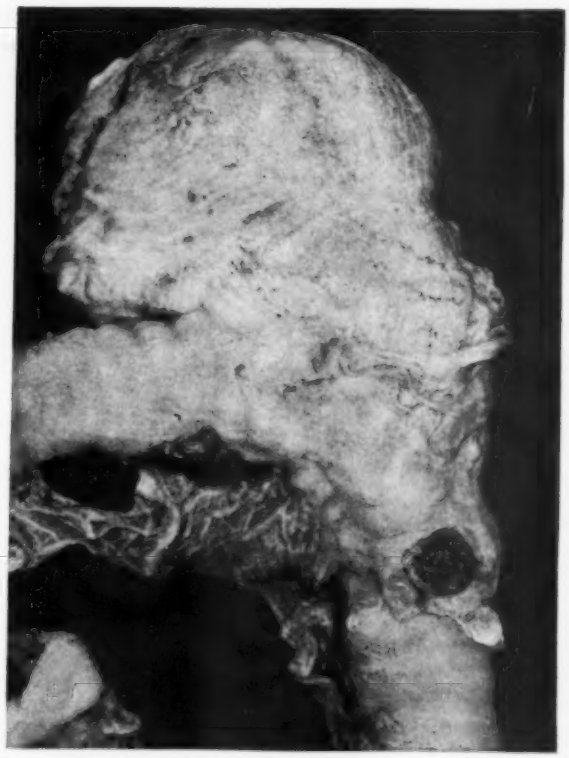

FIG. 2. Perforated jejunal ulcer in Dog 6. Finsterer type of operation is evident. Stomach remnant had hypertrophied some and jejunum at site of ulcer and just below had dilated and hypertrophied to a slight extent. Dog died of peritonitis at four months and twenty-three days.

Observations on the effect of gastric resection on gastric secretion in the dog have been made by Ivy and Whitlow,[3] Smidt,[4] Portis and Portis[5] and Steinberg, Braugher and Vidgoff.[6] Smidt found that resection of the pyloric antrum (Billroth 1) decreased the chemical phase of gastric secretion in Pavlov pouch dogs. Portis and Portis found an absence of free acid in the main stomach, three weeks, a very short period, after a Polya type of resection of the antrum, but found free acid in the usual amount in the juice secreted by the Pavlov pouch, which was also found by Ivy and Whitlow. The findings of Steinberg and his associates were essentially confirmatory of those of Portis.

METHODS

The type of resection performed by us was very much like that employed

* Submitted for publication October 8, 1931.

by Finsterer in man. The portion of the stomach resected was from the pyloric sphincter to a line drawn from a point on the lesser curvature 1 cm. proximal to the incisura angularis to a point opposite on the greater curvature. The portion resected amounted to approximately 66 per cent of the stomach. About 3 cm. of the gastric incision from the lesser curvature was closed with sutures and the remaining stoma was anastomosed to the side of the first loop of jejunum, stitches being taken to prevent angulation on the proximal side of the anastomosis in an attempt to reduce the likelihood of retrograde filling of the duodenum. The end of the duodenum at the pyloric sphincter was closed. The anastomosis was made without placing clamps on the intestine. The dogs were fed a diet of cooked yellow corn meal, bread and bone soup with meat and milk. The weight and appetite of the animals were observed, and in those that lost weight, special attention was given to feeding. Gastric analyses were made at intervals of several weeks and samples were withdrawn two, three and four hours after the test meal of 250 gm. of "fox food" and 150 c.c. milk. The meal itself on titration yielded no free acidity and thirty-two clinical units of total acidity. The emptying time of the stomach was followed under the fluoroscope. At intervals the dogs were given all of the barium impregnated meat they would voluntarily eat and a tracing of the stomach on the fluoroscopic screen was made. In this way we could follow the "hypertrophy" of the stomach without resorting to the use of *x*-ray plates. All autopsies were done immediately or very soon after death.

FIG. 3. Hypertrophied stomach of Dog 8 that died of inanition and pneumonia at three months and twenty days. Photograph reduced one-half. No ulcers were present. Defects in gastric and jejunal wall were made for purpose of microscopic study. Tissue was removed from six different areas and revealed presence of parietal cells throughout up to mucosa surrounding cardia. Jejunum was slightly dilated and circular layer of muscle was three times thicker than normal. Note that jejunal hypertrophy in this dog was confined to that portion opposite stoma. Stomach converted itself into Polya type of anastomosis.

FIG. 4. Perforated jejunal ulcer in Dog 11, which died of peritonitis at five months and ten days. This dog's stomach had hypertrophied to its original size.

RESULTS

Of 16 dogs operated upon, 12 lived more than three months. The 3 dogs that died, died at from one to two months of a low grade peritonitis. Table 1 shows the results of the operation very briefly, the incidence of the development of jejunal ulcer, the hypertrophy of the stomach and jejunum, and the gastric analysis and emptying time.

Nutrition: Of the 12 dogs, 5 (Dogs 1, 2, 5, 9, 12) remained in excellent condition throughout the period of observation. The other seven remained in good condition for periods varying from one to four months. The disturbed nutrition of 3 of the 7 (Dogs 4, 6, 11) was caused by the occurrence of a jejunal ulcer. In the other 4 (Dogs 3, 7, 8, 10) the disturbance of nutrition was due to inadequate digestion. Three of these 4 dogs had marked polyphagia and ate voraciously about twice the amount of food fed other dogs of the same weight. Large bulky stools were passed that contained much undigested material. The remaining dog (Dog 3) ate irregularly and slowly without much appetite. This dog acted after the first four months as if a jejunal ulcer had developed, but none was found at autopsy and the stools were not tarry.

Jejunal Ulcer: A jejunal ulcer occurred in 3 of the 12 dogs (Dogs 4, 6, 11) which caused death. In one other dog (Dog 9) a healed jejunal ulcer was found at autopsy. The jejunal ulcers as judged from our records of the behavior of the dogs developed from three to four months after the operation.

Hypertrophy and Dilatation of the Stomach and Jejunum: Hypertrophy and dilatation of the stomach occurred in 6 of the 12 dogs. The stomach returned to normal size in 4 and in the remaining 2 dogs no definite hypertrophy resulted. At autopsy we distinguished between hypertrophy and dilatation by the presence of rugae or folds of mucosa, the mucosa being in folds in all dogs. Fluoroscopic studies at intervals revealed that the hypertrophy was quite evident at two months and was maximum at six months. Histological study showed that the hypertrophy was real. For example in Dog 8, in which at three months and twenty days the stomach at autopsy was twice the normal size (Fig. 3), the mucosa was in folds throughout and there was a definite area in the fundus along the greater curvature which was distinctly lighter in color and contained some cells in mitosis. Well-developed fundic glands with parietal cells were present throughout the gastric mucosa up to the cardiac mucosa. The wall of the jejunum opposite the stoma was almost three times thicker than normal, the hypertrophy involving chiefly the circular muscle layer. The jejunum was hypertrophied only in the dogs that manifested hypertrophy of the stomach.

Gastric Analyses: The control analyses of the gastric response to the test meal ranged maximally from 0 to 45 clinical units of free acidity and from 90 to 110 units of total acidity. The post-resection analyses, all of which are not given in Table 1, show that the acidity of the gastric contents returned about to normal (total acidity 70–110 units) in from three to five months. The two-hour acid values, except in the stomachs which failed to hypertrophy, were lower than normal.

Gastric Emptying Time: The control emptying time varied from four and one-quarter hours to five and one-quarter hours. After resection, the emptying time was reduced at the first observation made, about one month after the resection. The emptying time at three and six months postoperatively was reduced from one and one-half hours to two and one-quarter hours. It is significant that this reduction in emptying time occurred irrespective of the hypertrophy. The hypertrophied stomachs emptied the test meal as quickly as the stomachs that did not show hypertrophy.

"Polyphagia": The presence of an excessive desire to eat, which was satisfied

TABLE 1

RESULTS ON GASTRIC ANALYSIS AND EMPTYING TIME OF STOMACH OF DOGS SUBJECTED TO SUBTOTAL GASTRECTOMY

Dog No.	Duration of Experiment	How Expt. was Terminated	Ulcer	Hypertrophy of Stomach & Jejunum	Gastric Acidity*	Gastric Emptying Time†
1	14 mo.	Killed. Excellent condition	None	To original size	1 mo. F.A.—0 T.A.—80 6 mo. F.A.—21 T.A.—75 10 mo. F.A.—60 T.A.—100	3 mo. 3′ 15″ 6 mo. 3′ 00″
2	14 mo.	Killed. Excellent condition	None	To original size	1 mo. F.A.—0 T.A.—62 6 mo. F.A.—20 T.A.—90 10 mo. F.A.—20 T.A.—90	3 mo. 4′ 15″ 6 mo. 3′ 00″
3	7 mo.	Death. Inanition. Good cond for 4 mo.	None. Petechial hemorrhage in jej. opposite orifice	None	1 mo. F.A.—0 T.A.—60 6 mo. F.A.—15 T.A.—85 7 mo. F.A.—20 T.A.—72	3 mo. 3′ 50″ 6 mo. 3′ 20″
4	7 mo. 20 days	Death. Anemia due to hemmor. of ulcer. Good cond. for 3 mo.	Jejunal ulcer, 1½ × ¾″ almost perforated	Marked hypertrophy 2 × orig. size. Jejunum opposite orifice hypertrophied	2 mo. F.A.—0 T.A.—80 5 mo. F.A.—25 T.A.—85 6 mo. F.A.—20 T.A.—70	2 mo. 3′ 15″ 5 mo. 3′ 00″
5	13 mo.	Killed. Excellent condition	None	Slight hypertrophy above normal	1 mo. F.A.—0 T.A.—70 5 mo. F.A.—3 T.A.—67 6 mo. F.A.—5 T.A.—80 10 mo. F.A.—10 T.A.—90	1 mo. 3′ 00″ 6 mo. 2′ 40″
6	4 mo. 23 days	Died. Perforated ulcer. Good cond. 3 mo.	Jejunal ulcer just below anastomosis	Some hypertrophy but not to original size	1 mo. F.A.—0 T.A.—80 ?	1 mo. 4′ 55″ ?
7	4 mo. 16 days	Inanition. Good cond. for 2 mo.	None	Dilatation & hyper. 2 × original size. Some hypertrophy of jejunum	1 mo. F.A.—0 T.A.—65 4 mo. F.A.—18 T.A.—85	1 mo. 3′ 30″ 4 mo. 3′ 00″
8	3 mo. 20 days	Died. Pneumonia, inanition. Good cond. for 1 mo.	None	Dilatation & hypertrophy 2 × normal size. Jej. hypertrophied	3 mo. F.A.—10 T.A.—72	1 mo. 3′ 40″ 3 mo. 3′ 00″
9	11 mo.	Killed. Excellent condition.	Healed ulcer of jejunum peritoneal adhesions at site of ulcer.	Hypertrophy 2 × normal hyper. of jej. opposite orifice	3 mo. F.A.—0 T.A.—80 6 mo. F.A.—10 T.A.—110	3 mo. 3′ 20″ 6 mo. 3′ 15″
10	6 mo. 21 days	Died. Distemper with peritonitis. Good cond. for 3 mo.	None	Stomach 2 × normal. Marked hyper. Some dilation & hyper. of jejunum	3 mo. F.A.—20 T.A.—65 6 mo. F.A.—50 T.A.—110	3 mo. 2′ 30″
11	5 mo. 10 days	Died. Peritonitis. Good cond. for 3 mo.	Perforated jejunal ulcer just below anast.	To original size	3 mo. F.A.—0 T.A.—90 5 mo. F.A.—5 T.A.—84	3 mo. 3′ 0″
12	4 mo. 10 days	Killed. Good condition	None	Dilatation & hypertrophy 2 × normal	None	None

* Highest value of a 4 hr. gastric analysis. F.A. stands for free acidity and T.A. for total acidity. Preoperative analyses ranged from 0–45 units for free acidity and from 100–110 for total acidity.

† The normal emptying time for the test meal used varied from four and one-half to five and one-fourth hours. The data given on the emptying time in the table is in hours and minutes.

in all dogs, appeared in 9 of the dogs (Dogs 1, 2, 4, 5, 7, 8, 9, 10 and 12). This we believe was due to a lack of proper digestion as is shown by the fact that these dogs passed bulky stools containing undigested food. This is also true of dogs which have had the pancreatic ducts successfully ligated.

DISCUSSION

The important point that this work demonstrates is that the stomach may undergo considerable hypertrophy after resection. In one-half of the dogs operated upon the stomach not only returned to normal size but became larger than normal. Definite hypertrophy occurred in 9 of the 12 dogs. As the stomach hypertrophied, the gastric acidity returned to normal and plenty of acid was found at three or four hours even in the stomachs that did not show much hypertrophy. We had expected to obtain some hypertrophy, but not so extensive as was found in some of the dogs. Hypertrophy and dilatation of the jejunum only occurred in those dogs that had a hypertrophied stomach. The clinical literature on the after-effects of gastrectomy say practically nothing concerning the hypertrophy of the stomach. Finsterer and Cunha[2] state that symptoms attributable to the reduced size of the stomach disappear after two or three months because the jejunal loop dilates and not because of increase in size of the stomach. This was not true for our dogs which may be due to the possibility that our dogs were less judicious in eating after the operation and less sensitive to distress caused by distention. Obviously if the stomach of man tends to hypertrophy in the same way as that of the dog does, there being little reason to doubt such a fundamental biological property, the question arises, why resect the stomach except for well-established surgical indications?[7] It is quite obvious that if a patient with a subtotal gastrectomy can after a period of several months eat three regular meals a day some hypertrophy must occur somewhere, even though the stomach does empty more rapidly than normal. It is doubtful whether the jejunum can hypertrophy to such an extent that it is able to provide the volume required for a regular meal. We are not convinced that hypertrophy of the stomach does not occur more frequently than reported in the literature, and believe that if proper studies with a bulky meal (not barium milk) impregnated with barium were made, more or less hypertrophy would be found in the majority of cases in man. Of course it must be granted, because of species difference, that the findings in the dog may be an exaggeration of what actually occurs in man, but the results on the dog indicate that further careful studies of the nature of those made by Klein[8] on the acidity of the gastric contents following gastric resection must be made.

The very interesting and important question arises, namely, what is the cause of the hypertrophy? We at first assigned the cause of the hypertrophy to the jejunum. It is known that the duodenum and jejunum of some dogs and men are more susceptible to distention than others. It was therefore thought that in those dogs whose stomach hypertrophied, the jejunum was sensitive to distention and hence would contract when food was ingested, causing the food to be retained in the stomach, which resulted in "stretch hypertrophy." However, when we found that the emptying time of the stomach was reduced in all dogs, we were forced to give up this explanation at least in part. We next directed our attention to the factor of "polyphagia," or the rate at which the dogs ingested food and the amount of food ingested within a short period. We found that with but one exception (Dog 9) hypertrophy occurred in those dogs which rapidly ingested the food set before them. The dogs that manifested no hypertrophy of the stomach

ate slowly throughout the entire day and did not manifest hypertrophy. The exceptional dog (Dog 9) ate slowly. Apparently those dogs that ate slowly were distressed when they ate fast and refrained from so doing, which is exactly like the eating habits of dogs from which the entire stomach has been removed and the esophagus anastomosed with the duodenum.[9] Hence, we believe that the most reasonable explanation of the hypertrophy that occurs in the gastric remnant is due to fast eating of large quantities of food that some dogs persist in doing in spite of the fact that within a week or so following the operation fast eating causes them to vomit.

The fact that jejunal ulcers were obtained in 3 of the 12 dogs, or 25 per cent, is not surprising in view of the return of gastric acidity to normal in from three to five months. Mann and Williamson[10] obtained 100 per cent jejunal ulcers in dogs on anastomosing the end of the jejunum to the end of the stomach and diverting the alkaline juices to the ileum. Fauley and Ivy[1] confirmed the findings of Mann and Williamson, but only obtained 45 per cent of jejunal ulcers when a Polya gastrojejunostomy was done and the alkaline juices were diverted to the ileum, showing that the size of the orifice plays a role in determining the incidence of postoperative jejunal ulcer. In the dogs in this study in which the orifice was large and the alkaline juices were not diverted, we obtained an incidence of 25 per cent which is a somewhat higher incidence (5 to 10 per cent) than in dogs with a simple gastrojejunostomy. This is probably within the experimental error. This incidence of postoperative jejunal ulcer in the dog after subtotal gastric resection coincides with the incidence of jejunal ulcer following simple gastroenterostomy in man (4 to 30 per cent),[7,11] but does not coincide with the incidence of jejunal ulcer following gastric resection in man reported by Finsterer and Cunha,[1] Berg[12] and Strauss and associates,[13] in which the incidence was about 1 per cent. However, it is probably too early to obtain accurate statistics, especially in view of the report of Hurst,[14] who states that he has collected over one hundred cases of secondary ulcer following gastrectomy, and of Balfour[15] who has operated on 28 cases of recurrent ulcer following gastrectomy. That they do occur is agreed to by practically every writer who has performed a number of subtotal gastrectomies.[16,17] The advocates of gastrectomy state that in such cases "sufficient" stomach was not removed.

In view of the hypertrophy of the stomach that occurred in our dogs, it is not surprising that the acid values returned practically to normal. Some of our high values are undoubtedly due to the fact that the sample of gastric contents was removed at three or four hours when the stomach was about empty; but the dogs with a hypertrophied stomach after three to five months showed practically a normal acidity curve. This finding is not at variance with clinical findings,[16,17] especially since Klein[8] and Perman[18] found free acid in the gastric contents of those gastrectomized patients who had high acid values prior to the operation.

Judging from the reports of some,[1,12,13] however, the acidity of the gastric contents following "sufficient" gastric resection does not become adequate for the production of jejunal irritation and jejunal ulcer save in a small percentage of cases. The factors that are operating in an integrative manner are (a) the amount of stomach removed, (b) the amount of postoperative hypertrophy, (c) the rate of emptying of the stomach, (d) the amount of pancreatic juice and bile formed, which may be reduced when the food does not pass through the duodenum, (e) the amount of mixing of the alkaline juices in the stomach, and (f) the amount of inhibition of gastric secretion incident to reflexes from the distended jejunum, adhesions, and uncomfortable sensations following eating. In this connection Holinger, Kelley and Ivy[19]

have found that continuous jejunal alimentation in the dog markedly decreases gastric secretion for from one to two hours or longer after starting the feeding which is probably due to overdistention and irritation of the jejunum. The intestinal phase of gastric secretion then begins to operate and gastric secretion is resumed. Thus, in a stomach that empties rapidly after gastric resection, this inhibitory factor would play a role in decreasing the gastric secretory response to a meal.

The decrease in the emptying time of the stomach observed by us is in accord with the clinical literature.[13,20]

SUMMARY

Resection of at least 66 per cent of the stomach in 10 out of 12 dogs resulted in varying degrees of compensatory hypertrophy of the gastric remnant. It is believed that the hypertrophy was due to rapid eating of large quantities of food due to the polyphagia incident to inadequate digestion. The jejunum at the stoma was also hypertrophied. The emptying time of the stomach was permanently decreased in spite of the hypertrophy. The acidity of the gastric contents returned practically to normal in from three to five months. Jejunal ulcers developed in 3 of the 12 dogs.

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*Continued from page 408.

LOCAL SURGERY OF PAINFUL BACKS

WITH REPORT OF CASES*

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EVANSTON, ILL.

ETIOLOGY

IT is not the purpose of this paper to take up all the causes and treatments of pain in the back, but a short review of the subject with mention of the more common causes may be indicated. The etiology may be divided as shown in Table 1.

TABLE 1

CAUSES OF BACK PAIN

A. LOCAL

I. Inflammation.
1. Acute.
*a. Boils and carbuncles.
*b. Cellulitis.
c. Myositis or lumbago.
d. Of nervous system.
(1) Neuritis & Neuralgia.
(2) Anterior poliomyelitis.
(3) Meningo-encephalitis.
*e. Osteomyelitis.
f. Arthritis.
(1) Septic condition.
(a) Tonsillitis.
(b) Alveolar abscess.
(2) Typhoid fever.
2. Chronic.
*a. Osteomyelitis.
*b. Tuberculosis.
c. Osteoarthritis.
d. Syphilis.
(1) Arthritis.
(2) Gumma.
(3) Charcot joint.
*e. Anterior poliomyelitis.

II. Trauma.
1. Contusions.
2. Sprains.
*3. Dislocation.
*a. Spondylolisthesis.
*4. Fractures.
*a. Kümmels.
b. Body.
c. Processes.
*5. Combinations.

III. Tumors.
1. Benign.
a. Lipoma.
b. Fibroma.
c. Osteoma.
*d. Cord.
2. Malignant.
*a. Primary.
(1) Cord.
(2) Sarcoma.
b. Secondary.
(1) Carcinoma.
(a) Thyroid.
(b) Prostate.
(c) Breast.
(2) Hypernephroma.

IV. *Congenital.*
1. Anomalies & Malformations.
a. Absence of part.
*b. Asymmetry.
*2. Dislocations.
*3. Postural or mechanical.
a. Anomalies.
(1) Acute angle 5th & 1st.
(2) Lateral processes.
(a) Irregular.
(b) Asymmetrical.
(3) Impinging spinous process
(4) Defective closure.
(5) Incomplete union.
b. Incomplete sacralization.
c. Failure of union arch & body.
d. Posterior displacement 5th. L.

V. General condition.
1. Rickets.
2. Pernicious anemia.
3. Lateral sclerosis.
4. Thyrotoxicosis.
5. Pregnancy.
6. Neuroses.

B. REFERRED

I. Pelvic.
*(1) Malpositions of uterus.
*(2) Ovarian cyst.
II. Abdominal.
*(1) Appendicitis.
*(2) Cholecystitis.
III. Genitourinary.
(1) Nephritis.
(2) Pyelitis.
*(3) Nephrolithiasis.
IV. Disturbances of joints.
(1) Hip.
(2) Knee.
(3) Foot.
V. Thoracic.
(1) Intercostal neuralgia.
(2) Pleurisy.

* Operable cases.

* Read before the Evanston Branch of the Chicago Medical Society, March, 1931.

DIAGNOSIS

Naturally so varied a list of conditions causing back pain makes the diagnosis sometimes very obscure, and the cure difficult. However, by making a careful and complete examination of each case, including history, physical examination, laboratory and *x*-ray findings, we are usually able to arrive at the first, with hopes of obtaining the latter.

Fig. 1. Case 1. Lateral view.

Fig. 2. Case 1. Anteroposterior view.

Fig. 3. Case 11. Spondylolisthesis. Lateral view.

TREATMENT

Certain of these conditions then require relief at the source, medical, physiotherapeutic, orthopedic or manipulative treatment other than surgery, and in most cases these treatments should be tried first.

For certain acute inflammations the obvious treatment is surgery: incision and drainage; boils, carbuncles, cellulitis and acute osteomyelitis, if diagnosed.

1. Fixation Operation: Other conditions, usually more chronic, can be cured or relieved by some sort of fixation operation. In these operations the attempt is made simply to help nature out by holding

Fig. 4. Case 11. Spondylolisthesis. Anteroposterior view.

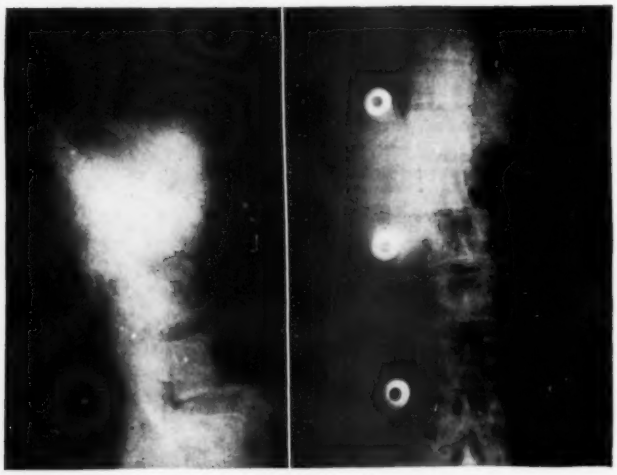

FIG. 5. FIG. 6.

FIG. 5. Case III. Fracture-dislocation of twelfth dorsal and first lumbar vertebrae. Anteroposterior view.
FIG. 6. Case III. Fracture-dislocation of twelfth dorsal and first lumbar vertebrae. Lateral view.

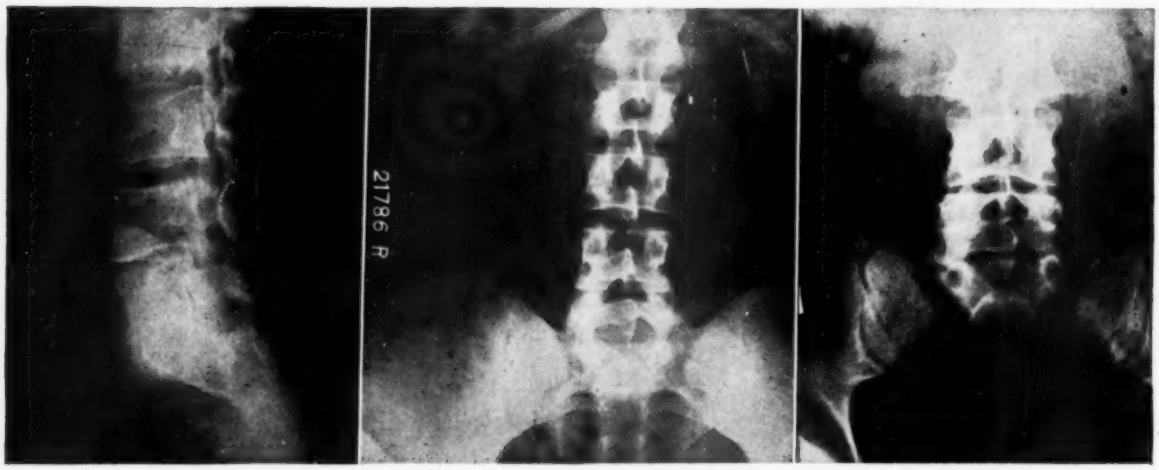

FIG. 7. FIG. 8. FIG. 9.

FIG. 7. Case IV. Lumbosacral strain. Straightened lumbar lordosis.
FIG. 8. Case IV. Lumbosacral strain.
FIG. 9. Case IV. Lumbosacral strain.

FIG. 10. Case V. Sway back; increased lumbar lordosis.

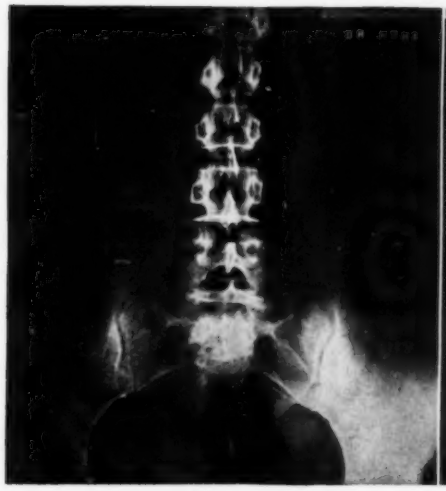

FIG. 11. FIG. 12.

FIG. 11. Case v. Sway back; lumbosacral strain.
FIG. 12. Case vi. Sacralization of right fifth lumbar vertebra.

FIG. 13. FIG. 14.

FIG. 13. Case vii. Fracture of anterior lip of fifth lumbar vertebra and sacroiliac arthritis.
FIG. 14. Case vii. Sacroiliac arthritis.

FIG. 15. Case viii. Sacroiliac arthritis.

FIG. 16. Case ix. Fracture of pelvis and sacrum.

the diseased, injured, strained, or deformed area quiet.

(*a*) *Fusion:* Here Hibbs' operation of spinal fusion, or some modification thereof, is satisfactory. If the pain is located in the lumbosacral region, or sacroiliac joint, a "trisacral" fusion is best, in which not only the vertebrae, but also the sacroiliac joints are fixed. As this last operation was rather recently introduced, a short description may interest.

Fig. 17. Fig. 18. Fig. 19.

Fig. 17. Case x. Osteoarthritis and tilting of last lumbar vertebra.
Fig. 18. Case xi. Lateral lumbar strain.
Fig. 19. Case xii. Narrowing anterior border of seventh dorsal vertebra; Kümmel's disease.

The incision can be a single elliptical one from above the posterior superior spines, convexly downward over the sacrum or three incisions over the vertebral spines, and the two posterior iliac spines. A regular spinal fusion is then done of the last two or three lumbar vertebrae, with the upper two

Fig. 20. Case xii. Old fracture. Kümmel's disease

Fig. 21. Case xiii. Pott's disease.

sacral, and then the two posterior iliac crests are split with a broad flat chisel or bone saw. The inner layer of this bone is

Fig. 22. Case xiii. Tuberculosis of first and second lumbar vertebrae.

removed and placed over the lumbosacral joints to reinforce that fixation, and the outer layer is bent inward across the sacroiliac joints, after chips are first gouged out near or within the joint for fixation. The fascia and skin are then closed with interrupted sutures without drainage, or if much oozing occurs, silkworm gut drains may be passed through punctures away from the incision. We then place the patient on his abdomen, or back, on an air mattress for six weeks. This gives support without pressure. After this a plaster jacket may or may not be used as desired.

Indications: In general the indications for these operations are:

(1) Tuberculosis of the spine (Pott's disease), especially in adults.

(2) Fractures of the spine, dislocations or a combination including always spondylolisthesis.

(3) Infantile paralysis with extreme weakness of the spine.

(4) Arthritis, especially the chronic type, and if not generalized.

(5) Sprains and strains, anatomical and mechanical variations, especially (a) lumbosacral; (b) sacroiliac.

(6) Congenital conditions or deformities: (a) scoliosis, (b) absence of part of vertebra, (c) inequality of two sides of vertebra.

Fig. 23. Case xiv. Fracture of eighth, ninth, tenth dorsal vertebrae.

2. Laminectomy: Another operation sometimes indicated is that of laminectomy. The chief indication for this operation is to relieve pressure upon the spinal cord, in cases of partial or complete paralysis. Here again we have the traumatic causes of fracture or dislocation of the spine. It is still a moot question as to whether these patients should be immediately subjected to operation, or not, but the consensus of opinion is that this operation should be done immediately upon such diagnosis. Occasionally there are cases of concussion or contusion of the cord, or of hemorrhage into the cord without fracture, or dislocation, which demand relief of pressure for paralysis, or prevention thereof. Then there are the inflammations again, as tuberculosis with paralysis. Lastly, tumors of the cord, membranes or vertebrae may require relief of pressure, and their removal.

CASE REPORTS

Case 1. L. W., female, aged forty-one, governess. (December 19, 1928.) Sprained

back in August, 1928 rescuing girl from drowning. Hurt ever since. Had treatment in Boston, wore leather jacket till October. Pain increasingly worse, then constant even in bed. Pain and tenderness located in lower lumbar spine. *X*-ray shows arthritis of lumbar spine.

January 28, 1929, Fusion done from second lumbar to second sacral vertebra, at Evanston Hospital.

Result: Pain in back entirely relieved from then on (Figs. 1 and 2).

Case II. R. W., male, aged twenty-one, automobile mechanic. (December 11, 1929.) Two years ago had sudden occurrence of pain in lumbar back from lifting a heavy oil barrel. Pain worse at night and after work, and constant ever since. Located in deep, over lumbosacral joint.

X-ray: Spondylolisthesis of fifth lumbar on first sacral vertebra (Figs. 3 and 4).

January 6, 1930. Trisacral fusion at Evanston Hospital. Left hospital in six weeks.

July 21, 1930, last seen with no more back pain, returned to work, doing everything.

Case III. K. T., female, aged thirty-two, housewife. (November 10, 1928.) Auto accident, open Packard car hit by another and turned over, with her doubled under it. Fracture dislocation of twelfth dorsal and first lumbar vertebrae (Figs. 5 and 6). Had also skull fracture, two broken ribs, fractured pelvis, and fractured left fibula.

In hospital on air mattress with traction until January 6, then went to New York City where she had spinal fusion done of four vertebrae in region of fracture dislocation.

Result: Now doing everything including riding horseback and jumping over hurdles.

Case IV. E. M. male, aged thirty-eight. (May, 1930.) Hurt back in Army in 1918 in auto accident; gradually bothered him more and more until it hurt in lumbosacral and sacroiliac region every time he got up after sitting. Could not play golf or do anything much without pain. *X*-ray showed rather straightened lumbosacral angle (Figs. 7–9). Did not wish operation at this time.

March 1, 1931, with another surgeon; wore brace for six months from May, 1930; after three months has had no more pain. Does not try anything except ordinary routine. Does not even play golf. I would advise trisacral fusion now, as here is a man thirty-eight years old incapacitated for any physical exertion either at work or recreation.

This is the type of back that gave 100 per cent cure with this operation in Dr. Hibbs' series of 147 cases of back strain.

Case V. H. G., female, aged thirty-four, housewife. (May 16, 1930.) Bad place in back, always had a sway back, which is steadily getting worse. Very painful and tired in one spot on right side at times. When changing posture and when sitting it hurts worst; also hurts when tired and when lying flat, so draws up knees. Feels as if she must lean over to relieve it. Sway back. Increased lumbar lordosis present even when lying on back. Tender and painful over upper sacroiliac region.

X-ray: Sway back. Posterior angle of sacrolumbar spine decreased (Figs. 10 and 11).

Refused operation. Spinal belt or brace might relieve her.

Case VI. L. W., male, aged eighteen, student. (June 2, 1930.) Hurt back on left side broad jumping one year ago; went to an osteopath and "had it jerked back into place." Recovered soon. Hurt again in basketball and then in baseball. Now hurts all the time. Worse when walks or gets up after sitting. Tender over left sacroiliac joint. All sciatic signs present.

X-ray: Left sacroiliac joint rough, and sacralization of right side of fifth lumbar vertebra, but not left, giving a congenitally potential weakness on left side (Fig. 12). Advised to stop strenuous athletics, wear sacroiliac belt, and have trisacral fusion done, if not well; or have operation and continue his athletics after six months. Chose the belt.

Case VII. T. B., male, aged forty-three. (January 11, 1930.) Seventeen years ago lifted a Ford car over and hurt back immediately. Sore for three weeks. Leaned over to walk. No treatment. Twelve years later was reaching over to pick up handkerchief and coughed, pain recurred and lasted one week. Third time, four years ago carrying ashes up the cellar stairs lost his balance. Lay in bed and had chiropractor treatment which made it worse. Occasionally bothered ever since. Hurts in small of back, cannot bend. No pain when flat. Wears sacroiliac belt.

X-ray: Sacroiliac arthritis, small piece off of anterior part of body of fifth lumbar vertebra (Figs. 13 and 14).

Advised trisacral fusion if pain continues, or unrelieved by sacroiliac belt.

Case VIII. R. R., female, aged fifty. (May 14, 1930.) Backache all her life. Ten years ago pain in back from leaning over to pick up a baby. Better for ten years but recurred last summer after golf lessons.

Examination: Pain and slight tenderness in sacroiliac joints. *X*-ray: Slight arthritis of sacroiliac joints (Fig. 15).

Treatment: Traction in bed, which relieved pain. Consider sacroiliac fusion if pain recurs and continues.

Case IX. D. W., female, aged twenty, student. (July 7, 1929.) Auto accident. Fracture of pelvis and sacrum, with rupture of bladder.

Examination: Ecchymosis and tenderness anteriorly especially near symphysis pubis and posteriorly near sacroiliac region.

X-ray: Multiple pelvic fractures (Fig. 16).

Treatment: Bed on air mattress with traction to legs. Cured. If it had not relieved pain in back, should have sacroiliac fusion to immobilize these joints and prevent sheering upward of pelvis. Unnecessary here because made a complete recovery, and now does everything including tennis.

Case X. A. N., male, aged forty-nine, laborer. (May 10, 1929.) Cook County Hospital Clinic because of pain in back.

X-ray: (15167E) "Osteoarthritis of lumbar spine and sacroiliac joints," also slight tilting of last lumbar spine causing a scoliosis (Fig. 17).

Treated by strapping spine and medication without relief, so entered hospital June 8, 1929, with history of pain in back, lumbosacral spine. This began fifteen or twenty years ago; when lifting a heavy load he felt a sudden strain in his back. Back had bothered him rather continuously since then. Has gone to several doctors, without help. Hurts particularly when he works, and more the last three or four years when pain has also run down into both legs.

Examination: Back, tenderness about fifth lumbar region, stiffness of lumbar spine, scoliosis to right in lumbar region.

June 10, 1929: Trisacral fusion, elliptical incision.

July 30, 1929: Left hospital walking without pain.

Case XI. R. N., male, aged twenty-six, laborer. (Records and history incomplete.) Painful lumbosacral spine for some time (Fig. 18). Unable to work. May 17, 1927, entered Cook County Hospital for lumbosacral fusion. Left hospital six weeks after operation, without pain.

Case XII. J. S., male, aged fifty, carpenter. (August 9, 1929.) First seen at Cook County Hospital. June 15, 1929, scaffold broke with patient, and he fell sixteen feet with scaffold on top of him. Hurt his back. Was told that *x*-ray at the time showed no fracture of the spine. Now has pain in region of seventh dorsal vertebra.

X-ray: Narrowing of anterior border of seventh dorsal vertebra. Kümmel's disease (Figs. 19 and 20).

October 14, 1929: fusion of three vertebrae.

Result: Back much better, but is suing company, and still complains of his back.

Case XIII. M. G., female, aged thirty-five, housewife. (November 10, 1930.) Pain in back three and a half years, since birth of her last child. In October, 1930 symptoms and *x*-ray made diagnosis of tuberculosis of first and second lumbar vertebrae (Figs. 21 and 22).

At Evanston Hospital November 24, 1930 fusion of eleventh and twelfth dorsal and first four lumbar vertebrae.

Result: January 15, 1931. Back pain has been relieved. Is now fever free for six weeks, and has gained weight. Now wearing Taylor brace.

Case XIV. J. N., male, aged twenty-two (?), restaurant worker. (February 27, 1929.) Auto accident. Fractured right scapula and bodies of eighth, ninth and tenth dorsal vertebrae. Very little pain. (Fig. 23.)

Treatment: Air mattress with traction for six weeks, spinal braces for eight months. Operation indicated, but not advised because of mass of furunculosis and boils all over back.

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NEW INSTRUMENTS

A SEMI-FLEXIBLE BRACE

FOR THE SUPPORT OF THE LONGITUDINAL AND ANTERIOR ARCHES OF THE FOOT*

WALTER I. GALLAND, M.D.

NEW YORK CITY

THE difficulty in comfortably fitting with metallic braces the patient suffering from combined prolapse of the anterior and longitudinal arches is frequently most baffling and at times well nigh impossible. The discomforts complained of by the patients are manifold. Usually on account of the inflexibility of the braces there is a tendency for the shoe to slip at the heel. This is caused by the fact that the brace fails to flex with the metatarsal-phalangeal articulations upon completion of the step and the rigid brace thus acts as a lever, forcing the back of the shoe away from the foot. It is obvious that the inflexible brace cannot furnish support to the constituent parts of the foot throughout its entire excursion in walking. Actually, the arches rest completely upon such an inflexible brace only when the foot is placed directly under the body axis as it is in standing. The rigid brace in walking is converted into an inclined plane at the completion of each step, and either acts as a splint effectively preventing the normal flexibility of the foot or causes the foot to slide forward along its smooth rigid surface as it comes into equinus during the step. This unyielding unresilient support frequently causes extreme discomfort and even pain on account of the sliding of the foot and the changed position of the foot in relationship to the brace during the various phases of each step.

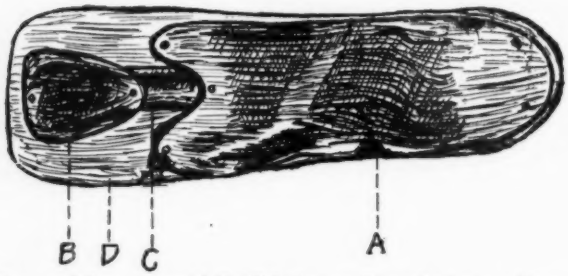

FIG. 1. View of semi-flexible brace from bottom, showing manner of insertion of metatarsal button. Distance between longitudinal and metatarsal elements of this brace will of course vary with individual foot. Various parts of brace are held together by rivets indicated in drawing. A, Longitudinal arch support. B, Anterior metatarsal button. C, Flexible metallic band. D, Leather covering.

The brace herein described was designed to lessen some of the disadvantages of the rigid brace and to provide a more effective support to the anterior metatarsus, and to take care of the longitudinal arch without sacrificing the strength of the brace.

The modification which secures this desirable flexibility is applicable to most of the usual types of foot braces, including the Shaffer, the Whitman and the simple sole-plate braces. It consists in anchoring a metatarsal button preferably of triangular shape to the longitudinal section of the brace by means of a malleable metallic band. This button is placed with the base anteriorly under the metatarsal heads and the apex is riveted to the metal which links it to the longitudinal arch. The anterior edge of the plate for the longitudinal arch carries an indentation which permits the anterior button to be placed close to the longitudinal plate, if this is found necessary in adjusting the brace. The entire plate thus constituted is covered with thin sole-leather which should be moulded by the bracemaker over the plaster cast of the foot without wrinkling. This leather covering should extend anteriorly as far as the base

* From the Orthopedic Services of Dr. Charles H. Jaeger, Lenox Hill Hospital, and Dr. Harry Finkelstein, Hospital for Joint Diseases, N. Y. Submitted for publication November 9, 1931.

of the toes. It is fastened with copper rivets to the metallic sections of the brace. The flexible band which connects the anterior and posterior sections permits bending of the metatarsal upon the longitudinal segments of the brace. Thus provision is made for motion between the component portions of the apparatus. It will be seen that the metatarsal button will remain in contact with the metatarsus and be firmly planted with its base resting fully upon the sole of the shoe throughout the entire extent of the step, while at the same time the longitudinal brace by virtue of the flexible segment constantly follows and supports the longitudinal arch. The illustrations will perhaps clarify details of construction and the mechanics of this device.

Fig. 2A.

Fig. 2B.

Fig. 2. A. Brace as it rests in a shoe. Angulation of anterior button in relation to longitudinal arch necessitated by heel of shoe is indicated. B. Position of brace at termination of step, illustrating flexion of brace at metatarsal longitudinal junction. It will be noted that anterior button remains in firm apposition with sole of shoe during entire step.

In building the brace the greatest difficulty lay in securing a metallic band which would provide flexibility and at the same time would be durable and would not crack under the strain imposed upon it in walking. The first braces of this design which were constructed carried various types of springs to link the metatarsal button to the brace. It was soon apparent that no spring was able to stand the repeated bending around a very short arc, to which the connecting band must be constantly subjected. After many trials it was found that the most effective band and one which combined the utmost flexibility with the maximum durability was a malleable steel strip measuring $\frac{5}{8}$ by $\frac{1}{32}$ inch. This is cut to appropriate length and fastened with rivets which extend through the leather covering to which the anterior edge of the metatarsal button is riveted.

The metal strip joining the two segments of the brace should be so bent as to compensate for the heel of the height commonly worn by the patient. This bending permits the proper inclination of the posterior section of the brace, while at the same time the anterior button rests parallel with the ground, and affords a firm support for the metatarsal arch in the accustomed posture of the foot as it rests in the shoe.

Although steel or any of the heavier alloys may be used in constructing the brace, I have found that aluminum or aluminum alloy is sufficiently strong for even the heavier patients. The rigid type of foot plate usually fractures at the junction of the anterior and middle thirds where the plate receives a shearing stress due to its inability to bend with the flexion of the forefoot. In the divided type of brace fracture is not likely to occur at this point, because it is here that the flexible element is inserted. We are thus able to use a lighter metal and not sacrifice the wearing qualities of the brace. The metatarsal button may be of metal or, in patients who exhibit extreme sensitivity of the anterior metatarsus, of sponge rubber. I have used this type of brace in approximately 100 cases.

THE LAVOIE SPLINT

IN FRACTURES OF THE HUMERUS*

G. S. FOSTER, M.D.

MANCHESTER, N. H.

MY colleague and friend, Dr. Z. A. Lavoie, has devised a very ingenious splint for use in fractures of the humerus which seems to merit special attention. The mechanical knowledge always so ably shown by Dr. Lavoie has resulted in this special splint in an appliance which gives satisfactory results.

FIG. 1. Splint applied showing traction of the arm.

Fractures of the humerus, in any location, are always difficult injuries to deal with. Any form of apparatus which will render comfort to the patient and at the same time produce very satisfactory functional and appositional results, as well as excellent alignment, is, to say the least, a most welcome addition to the great number of fracture splints now on the market.

In our clinic we have used the Lavoie splint in several cases of fracture of the humerus with very satisfactory results in each instance. In all fractures of the upper end of the humerus we consider it indispensable.

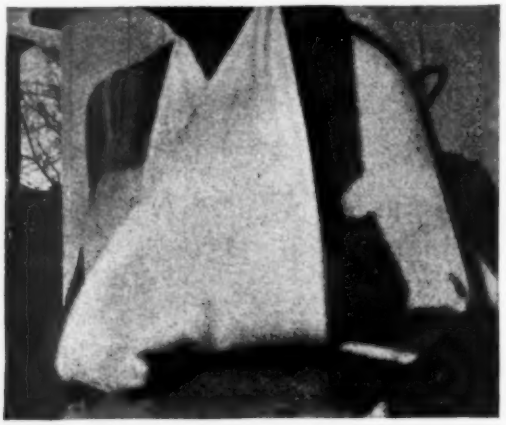

FIG. 2. Splint applied, showing forearm resting in sling. (Notice extension straps.)

Its application can be made without the use of any anesthetic, thus relieving the patient of this extra strain and discomfort. Furthermore the proper use will give a very satisfactory apposition and alignment in almost every case.

Another very important point favoring the use of the Lavoie splint is that frequent readjustment without disturbing the tension power of the extension can be made. Constant extension or traction upon the lower fragment can be maintained and increased with no disturbance to the patient.

The satisfactory results obtained through the use of the Lavoie splint have prompted us to report it with the following description of the splint and the method of its application.

DESCRIPTION OF THE LAVOIE SPLINT

The splint is constructed of two parallel steel rods, A and B, placed approximately

* Submitted for publication November 4, 1931.

4 inches apart. A is the inner rod and B is the outer rod. The upper end of the outer of these two rods, namely rod B, is continued inward and upward forming two steel supporting braces D and C, which at a point opposite the upper end of the inner rod curve inward and downward so as to meet at the upper extremity, this latter curve forming support of this inner rod E. Thus it is seen that this outer rod, having an expansion D and C at the upper end, curves anteriorly and posteriorly, inward and upward, turning at the inner row to curve downward and inward, E. By this three-way curve, D, C and E, a heart-shaped rod brace results which firmly unites the upper ends of the two perpendicular parallel rods. The inner leg E of this heart-shaped triangle is well padded and covered with soft, smooth leather for protection to the axillary surface of the counter extension bearing force.

The lower ends of the two perpendicular parallel rods are threaded for a distance of 4 inches, K. Two steel plates, F and G, each 5 inches in length with a circular aperture at each end are then threaded onto the lower ends of these perpendicular rods.

The lower of these two horizontal plates, namely G, is held firmly in place at the lower ends of the perpendicular rods by two fixing nuts, L and M, one placed above and one below the plate. Thus the two perpendicular rods are held firmly fixed.

The upper of the two steel plates, namely F, shades freely along the perpendicular rods over the threaded surface. At both extremities of this plate on the upper surface is attached a steel hook, H-H.

Fig. 3. Splint applied, showing ability of patient to use hand and forearm some while there is perfect extension on upper arm.

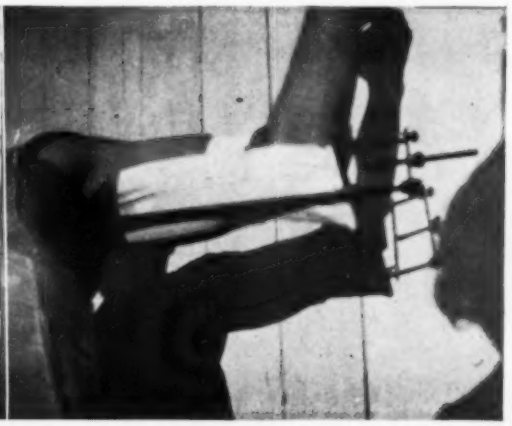

Fig. 4. Abduction of upper arm accomplished with relative ease. Splint applied and extension produced.

At the mid point on the under surface of this upper horizontal plate is attached a threaded rod, I, 5 inches in length. This threaded rod passes perpendicularly down through an opening in the center of the lower horizontal steel plate G, and an adjusting thumb nut, J, is then threaded onto this rod below the lower plate.

Two steel rolls, N-N, 3 inches in length, having a steel eye at the center are then hooked by these eyes on the hooks at the extremities of the upper steel plate F. These rolls N-N will thus be horizontal but perpendicular to the upper steel plate. Thus correctly assembled the splint is ready to apply.

From the description of this splint it is very obvious that the upper, horizontal steel plate can be moved upward or downward at will by merely turning the adjusting thumb nut to the right or left as desired.

APPLICATION OF LAVOIE SPLINT

To apply the Lavoie splint it is passed up over the upper extremity so that the padded brace, E-E, will fit snugly into

the axilla with braces D and C covering the deltoid muscle. Parallel, upright rods A and B thus run downward, the former along

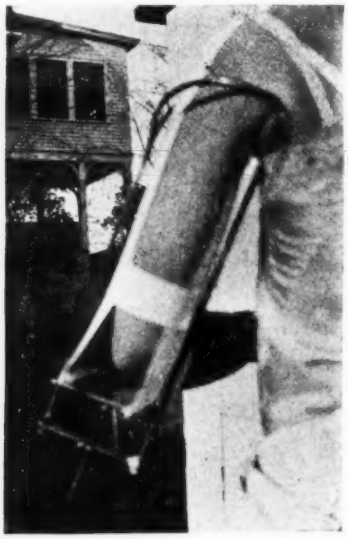

FIG. 5. Rear view of splint as it appears when traction is applied. (Note circular adhesive straps for retaining traction straps in position. Also indicated degree of traction of upper arm.)

the inner, lateral aspect of the upper arm and the latter along the outer lateral aspect of the upper arm. By this application of the splint the elbow will rest between the parallel, upright rods A and B at a point 4 to 6 inches above the steel rolls N-N.

Adhesive straps 3 inches wide are now applied to the inner and outer lateral surfaces of the upper arm, beginning at a point just below the site of fracture. These adhesive straps adhere to the skin for a distance of from 4 to 6 inches. These adhesive straps are reinforced by adhesive straps 3 inches wide circling the upper arm but not tightly enough to produce any constriction. Generally two of these circling adhesive straps are sufficient, placed about 2 inches apart.

The free lower extremities of the first adhesive straps are then split upward along the median line for a distance of 2 inches and then wound upon the steel rolls N-N. Several turns of these rolls are necessary to warrant holding. The steel rolls N-N are then attached to the hooks H-H on the horizontal plate F. When thus attached the adhesive straps should be quite taut.

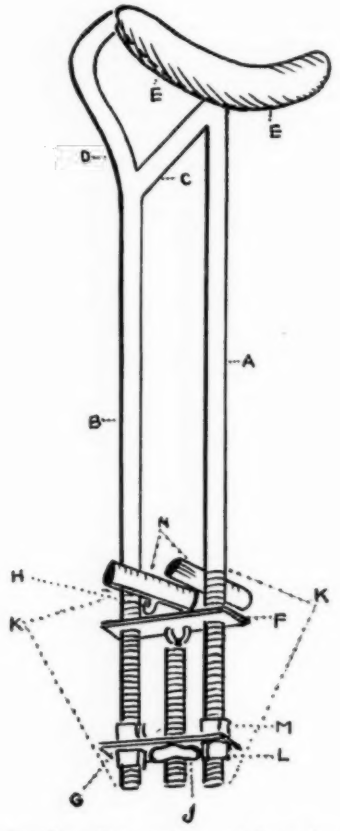

FIG. 6. A and B, Parallel steels, upright rods; A, inner, B, outer. D and C, Curved, supporting braces by expansion from upper end of upright rod B. E, Padded, supporting, curved brace uniting brace rods D and C, thus completing heart shaped upper extremity D, C, and E. K-K, Threaded section of parallel, upright rods. F-G, Horizontal steel plates threaded over parallel, upright rods. F, Movable on parallel, upright rods. G, Stationary as held by fixing nuts L and M. H-H, Steel hook attached to horizontal plate F at each extremity just inside parallel, upright rods A and B. I, Threaded rod attached to mid section of horizontal plate G. Screwed on over the lower end of this threaded rod is adjusting thumb nut J. This adjusting thumb nut J can be turned in either direction to release or extend as desired. N-N, Steel rolls with rings for attachment to horizontal plate F over hooks H-H. These rolls accept the extension, adhesive straps for proper extension and adjustment. The upper ends of the adhesive straps are attached to the upper arm below the site of fracture.

Thus applied the adjusting thumb nut, J, is turned to the right until proper traction is obtained as shown by the proper

apposition and alignment of the fractured ends above.

The forearm is then placed in a sling where it can comfortably rest in the position of flexion best tolerated by the patient. Thus the hand is left free for use in feeding or in accomplishing other functions. In fact the forearm can be flexed and extended at will and at certain intervals each day the sling can be removed so that such flexion and extension movements can be accomplished to keep the elbow free from any disability through loss of function.

From day to day the adjusting thumb screw J should be turned a little to maintain the proper amount of traction as shown by the surface conformity over the site of fracture and by the roentgenograms.

The Lavoie splint is a simple piece of apparatus most ingenious in its construction, easily applied, comfortable for the patient and does not produce any bodily surface maltreatment. It permits the patient to be up and about and in no wise interferes with the use of the hand and forearm.

Above all its simplicity of construction, ease of application, comfort and freedom rendered the patient, coupled with the most excellent results obtained in fractures of the humerus, would certainly warrant its universal adoption in these cases.

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EDITORIALS

THE IMPORTANCE OF THE HUMAN ELEMENT IN MEDICINE*

AS we gaze down the vista of medical history, we realize that it is a far cry from the beloved old doctor Milliken, in the O. Henry story, whose only equipment was "a can of calomel and a saw," to the skilled practitioner of today. This old doctor had the bedside manners of a Piute medicine man, and when he put his hand on a patient's head, they were said to feel like Captain John Smith just before Pocahontas went his bail. Yet, as my mind's eye travels down the Road to Yesterday, I see by the wayside many priceless assets which these old doctors possessed, and which have been cast aside in favor of skill and cold science.

In spite of the vast strides that have been made in medicine and surgery, it seems to me that there is a gradually widening breach between physicians and their patients, which makes some of us yearn for the reciprocal feeling which existed in other days. When the general practitioner held sway, there was a feeling of perfect understanding between physician and patient. The physician was not only a healer of bodily ills, but was father confessor, advisor, a close friend and ally in times

* Address given by the retiring president of the Los Angeles Surgical Society, December 30, 1931.

of stress. Perhaps he did not have the technique that is possessed by the present-day specialist, but he did have a world of tenderness and understanding that healed broken spirits and brought new hope to discouraged hearts.

He was never in a hurry, and therefore he was able to probe down and find the cause which so often had resulted in various mental and nervous afflictions. He had never heard of psychoanalysis, but his sturdy courage and understanding uplifted the spirits of his patients and brought about a desire for health which reacted to effect a cure. He administered to the entire family. He was not above dosing the family watchdog or setting the leg of the prize bull calf. The result was, that he became the community oracle and was respected and trusted within a radius of many miles. When he decided that a leg must be amputated or an appendix removed, he first explained the necessity of such operations. The victims knew that he would do his best, and even though he inflicted upon them the most frightful agony, and they became permanently crippled or went down to death, the family still had implicit faith in his judgment and skill.

In this day, that complete confidence has been sorely shaken. It is stated openly by opponents of surgery that the doctors operate for a fee and not for the benefit of the patient. Stage comedians talk of an open season on adenoids, and of the good old days before there was a bounty on tonsils.

The medical and surgical profession today is a great battleground occupied by many opposing forces. Various schools of practice rush into the newspapers, making claims for miraculous cures and cure-alls. They tell their story over the radio, on the bill boards, by means of form letters, and with the hundred and one other devices that are barred by the ethics of our organization. Secure in the knowledge that we are following the higher standards which have come down to us through the ages, we make no reply to this barrage of pseudo-medical shrapnel, but its effect upon the mind of the general public is far reaching and detrimental. It has tended to shake the faith of the afflicted of the civilized world in all branches of the medical profession.

The doctors created in the imaginations of fiction writers also have done much to undermine the confidence of the public. There have been a few physicians and surgeons drawn true to life, but the majority have been a caricature which derided the courage, courtesy, self sacrifice and kindliness displayed by the medical profession in general. If they are not pictured as cynical, selfish, ignorant or generally impossible, they are made into paragons who never could exist in reality, and who undergo ordeals and survive circumstances that have no prototype in life.

Our aim as men and surgeons is to reflect a true picture of our profession and to bring about a better understanding with the public we serve. We should explain to them, in words that they can understand, the necessities which have brought about the era of the specialist, and before we shunt our patients through a long series of specialists, we should impress upon their understanding that each one is a master of his art, that he has devoted his entire life work to his particular branch of medicine or surgery, that no one physician or surgeon, though he lived to be as old as Methuselah, could possibly be expert in every branch of our profession, that when we refuse to make a complete diagnosis, we are working toward the end that our patient shall have every insurance against disease and death, and that only in this manner can a true picture be obtained when our patient is suffering from some obscure or baffling ailment. If we do not surround these explanations with a multitude of technical terms, we will build up that confidence in ourselves which is now so vitally lacking. We will resume the place held in the hearts of nearly everyone who formerly depended upon the old fashioned family physicians. We will cease to be

medical and surgical automatons and become, in the minds of our patients, human beings whose sole aim is to promote their health and happiness, men with an understanding of the trials and tribulations which continually afflict the world. We will still remain specialists, for only in this way can the best interests of humanity be served.

While it is necessary for the physician and surgeon today to exert himself for the best in science, it also is vital that he shall not lose the human touch which gave the old country doctor his priceless worth. We surgeons should not allow our patients to become merely cases. Ministering to the physical needs of humanity demands more than the wielding of the scalpel and the prescribing of drugs. There should be a bond between the physician and the sufferer that cannot be diagrammed. His heart must reach out with pity and understanding to the afflicted. Unless this is so, the faith, hope and trust which are necessary to the successful practice of medicine and surgery will be lacking.

Accurate diagnosis and scientific treatment are important, but the human element is equally essential. Neither can stand on its own feet unaided and be true to the standards set up by our profession. We, today, are threatened with becoming medical Robots, coldly scientific, highly skilled, but without hearts. I feel that each of us, when the time comes to face the surgeon's knife, wants more than just a skilled operator. We would like to feel that the man performing the operation cares a little bit about our personal welfare. It is true that we cannot allow sympathy to impair technique or efficiency. We must not brood over failures, but must learn from them without losing courage.

A striking example of skill and human understanding was given by Sir William Osler. It is said that he always left behind him in the sickroom, hope and courage, which played a large part in his healing ability. It is this glorious combination of superlative skill and gentle tenderness which should be the aim of every surgeon. Flawless technique cannot take the place of sympathy.

If we build only on science and cold skill, we will erect a Frankenstein which will destroy us. There is no memory more beautiful than that of the old time country physician, who served his widely scattered flock twenty-four hours in the day. The mere knowledge that he was on the way to the sufferer brought a certain peace to the patient, and courage to the household. They knew he would give his best in their service. He bore their sorrows in his own heart; he brought their children into the world; he closed the eyes of the old folks in death and left a comforting word. He gathered more love than any other individual in the community. He had little time for scientific study, but men have won the Croix de Guerre for less distinguished service to their fellow man. We, today, should strive for the fundamental understanding which made these men great, and etched their history in the hearts of endless generations.

BURNS CHAFFEE

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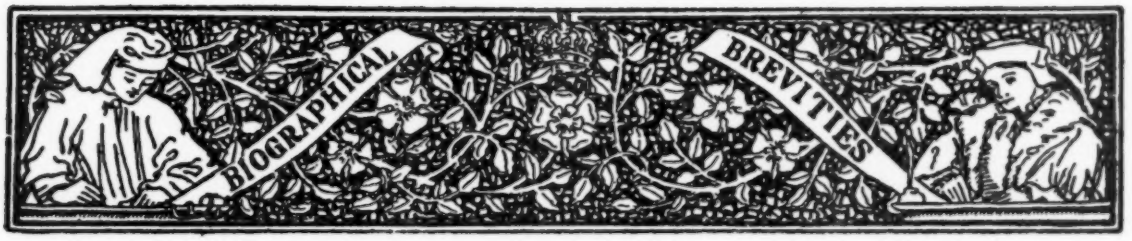
WILLIAM PAUL CRILLON BARTON

[1787?-1855]



WILLIAM PAUL CRILLON BARTON

WILLIAM PAUL CRILLON BARTON was born in Philadelphia, November 17, 1786. His was an illustrious family. His father, William Barton, was a distinguished lawyer and designed the United States Seal. His brother, John Rhae Barton, was the originator of Barton's bandage, while an uncle was Benjamin Smith Barton, Professor of Botany in the University of Pennsylvania, and the successor to Benjamin Rush as Professor of Theory and Practice of Medicine in the University.

William graduated (A.B.) from the College of New Jersey (Princeton) in 1805 and received his M.D. at the University of Pennsylvania in 1808. He entered the navy as assistant surgeon the following year.

He was ordered to the United States in 1809 and found the lack of medical facilities and system deplorable. This led to his constant agitation for better supplies, a better system, and improved medical care of the ill, which agitation continued without abatement throughout his life.

He tired of sea duty after cruises on the *United States* and the *Essex* and requested and was granted duty in Philadelphia where he remained more or less until 1830. Among other accomplishments he abolished the nefarious custom of venereal fees in the American navy.

In 1814 he published, "Treatise Containing a Plan for the Internal Organization and Government of Marine Hospitals, and a Scheme for Systematizing the Medical Department of the Navy." Later he did a two volume work on "Medical Botany" and a "Compendium Florae Philadelphiae." In 1815 he was made Professor of Botany at the University of Pennsylvania.

Barton believed in higher standards of selecting recruits and felt much of the sick list was the result of accepting men physically below par.

In 1840 he made a West Indies cruise aboard the *Brandywine*. On the short trip 488 became ill, mostly with typhoid, scarlet fever, pneumonia and malaria. Barton wrote a work entitled, "Hints for Medical Officers Cruising in the West Indies."

In 1830 he was ordered to the Naval Hospital at Norfolk which had just been completed. The following year he returned to Philadelphia as senior member of the Naval Examining Board. In 1841 he advocated the keeping of a complete journal of all patients. The next year (1842) several new bureaus were formed and Barton was chosen the first Chief of the Bureau. Although the first Chief, Barton was not the first surgeon general of the Navy as the title was not created until 1869.

He had many staunch friends; also, many bitter enemies who resented his spirit of reform. His "liquor circular," limiting the use of medical liquor on shipboard, caused feeling to run high in the fleet.

In 1844 he resigned but while Chief, among many other things, he established a medical library for each naval medical unit. After resigning his office he served at the Pensacola Naval Hospital for about four years. He then became senior member of the Examining Board at Philadelphia. He remained in this position until his death, March 27, 1856.

In the Army Medical Museum at Washington there is a life-size bust of his likeness.

T. S. W.

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

THE ROLE OF EXPERIMENTS ON ANIMALS IN THE TREATMENT OF DISEASE*

MODERN PHARMACOLOGY

ARTHUR D. HIRSCHFELDER, M.D.

MINNEAPOLIS, MINN.

IN order to understand what can be reasonably expected from the treatment of disease by "drugs," we find it helpful in the first place to think of the human body as a machine; and like other machines the parts of the living body wear out with age, its valves may leak, its engines may grow feeble. We may increase the efficiency of an automobile engine by "drugs." We may improve its "digestion" and its "breathing." We may treat its "anemia" by means of a better mixture of gas and air. We may strengthen and stimulate its "heart" to stronger contractions with "ethyl gas." We may guard it against "fever" in winter by keeping in the radiator the proper cooling mixture.

In addition to being a simple machine, however, the human body can repair its tissues and organs by healing, by growing removed parts anew, or by sealing wounds with scar tissue. The organs of the human body are often capable also of growing larger and so do the greater amount of work which a chronic disease may force upon them.

The human body may be invaded by microscopic organisms, bacteria and microscopic animals, which grow and penetrate into them just as one sees a fungus growth penetrate into a tree and destroy it. In addition, these bacteria produce poisonous substances (toxins) which are carried by the blood, and like other poisons, may injure the heart, the brain and other organs, and thus may finally cause death. These bacteria, if they are on the surface of the body, are easily killed by antiseptics; but if they have penetrated into the body and are covered over by living or injured tissues, the ordinary antiseptics cannot reach them; and only a few special drugs which circulate in the body can kill them without also injuring the heart, or other organs. Many disease conditions that occur late in life result not from the entrance of bacteria years before, nor from their immediate presence, but because the scars formed in the injuries due to the original infections shrink steadily year after year, even after the original infection has subsided. This closes up

* This is the fifth of a series of articles on the value of animal experimentation in medical progress. The next article will appear in an early issue.

tubes or openings that are necessary for the preservation of life and health.

From all this we can see that in order to cure a disease, relieve a symptom or allay pain, each "drug" must produce a definite kind of change in the workings of the body.

Historical Note. The oldest drugs in use have come down to us from prehistoric times, their usefulness having been found as matters of experience. The ancients knew the purgative value of the waters from mineral springs, and the shrines of Aesculapius, and other great Greek physicians, who mixed religion with their medicine, were located near mineral springs. The ancient inhabitants of India found out that the seeds of their opium poppy would produce sleep and soothe pain, and opium was carried to Egypt, Greece and China along all the routes of old world commerce. The Arabians knew that the balsams and aromatic herbs contained something that helped the healing of wounds, and brought these primitive antiseptics with them to Western Europe; though only in the fiction of Walter Scott were they potent enough to heal infected wounds as Rebecca cured the wounds of Ivanhoe.

The alchemists experimented with mercury in the hope of turning it into gold. By a fortunate trial they used it successfully in a salve to curve the venereal plague of syphilis, which, whether or not it was introduced into Europe by the sailors of Columbus, was first found to overrun Europe just after the discovery of America.

A great heart stimulant, digitalis, the active substance in the common foxglove, was discovered accidentally by an English physician, William Withering (1741–1799) about the time of the American Revolution. He found that an old woman in the country had cured several people of dropsy, upon whom physicians had failed, by means of a tea she had made of a mixture of several herbs, one of which was the foxglove. Withering thought that his digitalis cured his patients of their dropsy by stimulating their kidneys. This we have since found to be incorrect. Almost a hundred years later the action of this drug on animals was studied by the English physician, Sir Lauder Brunton (1844–1916). He found that instead of stimulating the kidneys, it made the hearts of frogs and dogs beat slower and stronger, and therefore that it was a stimulant for the heart. In modern times it has been used as a heart stimulant and thousands of men and women live useful lives for ten and twenty years after they would have sunk into their graves but for Lauder Brunton's accurate experiments on dogs with the drug which Withering had given to the world, without knowing just how it acted.

Within the last twenty years this drug has been studied again from a different angle, and still greater benefits to humanity have resulted. A German physiologist, Theodor Wilhelm Engelmann (1843–1909), found that by touching the heart of a frog it beat again once, interrupting the regular rate of its contraction. He touched different parts of these frogs' hearts and made them contract irregularly in many different ways, and then showed that dogs' hearts responded in the same way as frogs' when they were touched in different parts. Ten years passed, and a country doctor, James MacKenzie, in a small town in England, puzzled by the irregular beats of his patients' hearts, began to study their pulses. He found that some pulses beat in two-step, some foxtrotted in four-step, some beat at a slow march of half-time, and some were out of step with every step and rhythm. He looked up Engelmann's studies on the hearts of frogs and found that the hearts of his patients acted just as those of Engelmann's animals had done. He reasoned that the disturbances in his patients must be quite like those that Engelmann had produced. This gave to physicians an entirely new understanding of hearts that beat irregularly. It was found that

some heart beats which had been previously thought to be signs of serious heart disease were merely normal heart beats or represented insignificant disturbances which needed no treatment whatever. This was especially true in many children, whose hearts are often a little irregular but who are otherwise perfectly normal, and do not need any treatment whatever, but can run play and fight like other children.

Others studied the exposed hearts of anesthetized dogs, and learned just what was wrong when the heart beats entirely out of step with any time or rhythm, the commonest and most dangerous ailment of all (auricular fibrillation). Then MacKenzie showed how this last disturbance could be controlled by digitalis, the heart made to beat slowly and strongly even though out of step. In 1916 Prof. Cary Eggleston (1884–) of New York together with Prof. Robert Anthony Hatcher (1868–) showed how doses of digitalis much larger than had ever been given before, doses which would make a doctor of the old days tremble with terror, were safe for animals and human beings. With these larger doses, patients panting for breath and swollen with dropsy on one day, were breathing quietly and free from dropsy and swelling on the next, with their pulse-beats large, strong and quiet though still irregular.

How a Drug Is Studied. Before we can use a "drug" safely and effectively, we must find out which, of all the substances that it contains, is the essential active factor. The first step is a chemical separation or manufacture. Then each substance must be tested out on animals. We must learn how it acts on each organ of the body in order that we may know in just what kind of condition it can be helpful. We must learn about how much of it will poison or kill an animal, to avoid such a dose when we give it to our patients. We must learn whether the dose that will produce the desired effect is too near to the dose that would injure or kill the patient; for very many substances produce useful effects in the body but do so only when they are given in a dangerous amount.

The newest drugs are usually built up step by step in chemical laboratories, starting with some known substance which has, in general, the desired action, but when tested on animals, is found to be too poisonous for practical use. The chemists then make a whole series of new substances, each just a little different from the others. Since it is impossible to foretell which will act most strongly and have the least poisonous action, each of these substances must be tested out on animals. The best of them is then selected and becomes the new drug.

The great German pharmacologist, Paul Ehrlich (1854–1915), laid down the rule that in order for a drug to be safe for treating human beings, it must produce the desired effect in one-tenth of the amount that might be dangerous. This ratio, $\frac{\text{dose that kills}}{\text{dose that cures}}$, the so-called therapeutic ratio, must be greater than 10. This is the rule that, since the discoveries of Ehrlich, guides pharmacologists to make new drugs that are better and safer than those which we had before.

The Drugs That Produce Sleep. It is difficult to realize that before Oscar Liebreich's studies in 1869, if a patient needed a night's sleep, a doctor could administer only alcohol or opium, and that thousands of persons innocently became the slaves of opium on this account. Oscar Liebreich showed by experiments on animals that sleep could be produced by chloral hydrate, a drug which was much less likely to form a habit in patients than opium, and yet would bring placid sleep to tired eyes. Experiments on animals showed that chloral is harmful to the heart and gave us the doses that can still be used with

safety, but not for persons whose hearts are weak. Later investigations by Eugen Baumann and Alfred Kast in 1888, gave us sulphonal and trional, less poisonous to the heart but slower in their action. Then the great Berlin chemist, Emil Fischer (1852–1919), who was trying to make artificial caffeine in the laboratory, in 1903 gave one of his new substances to a physician, Joseph von Mering (1849–). Von Mering tried it out on many rabbits and dogs and found quite unexpectedly that it produced sleep in doses that were much smaller and safer than any of the drugs used previously. Thus it became known that these drugs, now called barbital (veronal) and phenobarbital (luminal) and a host of other very similar drugs (amytal, dial, etc.) are the best and safest sleep-producing drugs in use today; and many a person who needs rest during an illness is saved from becoming an opium addict by these researches of Emil Fischer and the dogs of von Mering.

From the studies of Fischer and von Mering came a still further unexpected result. It was found that small doses of phenobarbital were far better than bromide of potassium for preventing attacks of that terrible disease, epilepsy, and that this result could be gotten without dulling the intellect of these unfortunates as bromides had done. Thus an additional boon was conferred upon mankind.

Later studies in this disease included the experimental treatment of the blood of dogs with simple acids and cooking soda (bicarbonate of soda) and the subjection of others to starvation followed by diets rich in fat but poor in starches which led to an understanding of the effects produced by slight changes in the alkalinity of the blood. These studies led Peterman and Harry Frederic Helmholtz at Rochester, Minnesota, to the demonstration that many children could be further saved from epileptic attacks, or the attacks made much rarer, by simply placing them on a diet rich in fats but poor in sugars and starches. As the outcome of experiments on animals, another awful disease had been mollified, and though not completely conquered, there are indications that it may be completely conquered in the not too distant future.

The Conquest of the Hookworm. The poverty and laziness of the "poor white trash," who made up such a large part of the population of the southern States at the beginning of the present century, was found to be due chiefly to the fact that most of them had parasitic worms (hookworms) in their intestines which sucked the blood through the bowel walls, and so rendered them anemic, listless and weak. Many drugs were studied in animals; and at last three drugs, thymol, oil of wormseed (chenopodium) and carbon tetrachloride (the ordinary non-inflammable cleaning fluid), were found which were safe to use in human beings and which would rid the sufferers of their hookworms without injuring the patient. By the cooperation of the Rockefeller Foundation and the Health Boards of the southern states, these drugs have been given to millions of men, women and children, who have become rid of their parasites and have become strong and well again. Indeed it is to the use of these drugs, and the vigor which they have brought to the native population, that one can ascribe in large part the prosperity which has come to the southern States in the last few years.

Amebic Dysentery. One of the most serious and stubborn diseases, which occurs widely in the tropics and very frequently also in all parts of the United States, is a certain form of dysentery, sometimes accompanied by abscesses of the liver. This disease is due to a microscopic one-celled animal about the size of the point of a pin, called the ameba, or more accurately, the *Entamoeba histolytica.* The amebae multiply and burrow

into the wall of the large intestine and in between its layers. There they remain hidden away, doing damage for years; and then they may even travel up to the liver and form big sacs or abscesses there. Many people die of this form of dysentery, and until a few years ago it was very resistant to all forms of treatment. But in 1912, Prof. Leonard Rogers in India and Col. Edward B. Vedder of the U. S. Army Medical Service began to treat this disease by injecting a drug called emetine under the skin. They had proved that this drug would circulate through the body and poison the amebae wherever they were found, both in the walls of the intestine and in the abscesses of the liver. It was the first time that this disease could be cured in any considerable number of cases, and this drug is still used for this purpose. However, as so frequently happens, the drug is quite poisonous to the patient; the dose necessary to cure is very near the dose that may cause unpleasant symptoms. It has therefore been necessary to get other drugs which would help out the action of emetine and which could be used with less discomfort. It was soon found the neoarsphenamine (neosalvarsan) would accomplish this purpose; and since 1923 another of the arsenic group of drugs (stovarsol), made by Prof. Fourneau of the Pasteur Institute in Paris, has been used with great success. One of the advantages of stovarsol is that it can be given by mouth instead of being injected into the veins; and except for occasionally causing diarrhea, it is very satisfactory. Still another drug has been used for this purpose, a preparation known as anayodin (yatrin), which is a quite simple and harmless compound that has been made and introduced in Germany. This drug may be given by mouth or used as an enema, introduced directly into the rectum so that it comes in close contact with the amebae. The action of anayodin and stovarsol, like other drugs, was not suspected until they had been tried out on animals, but now physicians have at their disposal three drugs which they may use, one after another, to bring about the cure of a disease which twenty years ago baffled every method of treatment and caused the death of many persons.

Leprosy. The most horrible and loathsome of all diseases known to man is leprosy, which disfigures the face, causes fingers, toes and noses of patients to shrivel and shrink, and kills thousands of people in the most awful manner. Throughout the centuries this disease has incited horror, and lepers have been banished to leper colonies on deserted islands and have been left there to die, accompanied only by a few faithful martyrs of physicians and attendants who often have themselves contracted the disease from the patients. No remedy was known until 1915, though there had been a belief among the inhabitants of India that an oil (chaulmoogra oil) from a certain Indian tree, gave some benefit when it was taken by mouth. In 1915, Prof. Leonard Rogers of India and Prof. Victor G. Heiser of the U. S. Public Health Service in Hawaii, with the collaboration of a staff of chemists, made several new chemical compounds from chaulmoogra oil. They tested these out on animals and found that they were not harmful, and from these experiments learned the dose that would be safe to give to human beings. These medicines for the first time in history really cured patients who had leprosy. The cure is slow, requiring at least ten months; and severe cases cannot be completely cured. But in thousands of cases the dread disease has been blotted out and the unfortunates have been able to return to their homes free from any contagion or blemish.

In the last three years, Professor Roger Adams of the University of Illinois, by a series of wonderfully skillful chemical syntheses, has prepared a number of new substances which are very similar to the chaulmoogra compounds in chemical

composition, but which, in the test-tube, are several times more active in their attack on the bacillus of leprosy, though when injected into animals they are no more poisonous. These are at present being tested out on patients with leprosy, and give new hope that soon this disease may be cured with greater certainty and greater speed than is at present possible with the derivatives made directly from chaulmoogra oil.

CONCLUSION

The foregoing represent a few of the controls over diseases that have been made possible only through experiments upon animals. In every field of disease, new experiments are in progress, new light is being thrown upon the cures yet to come, of diseases which are not yet conquered. For many of the commonest and most dreaded infections we still have no satisfactory drugs; but these can come only by continued study along the same lines as have brought success in the past.

GOVERNMENT REGULATIONS REQUIRING THE TESTING OF DRUGS UPON ANIMALS

Not only is experimentation upon animals necessary for the discovery of new drugs, but the laws of the United States require that every sample of certain important well-known drugs must be tested out on animals in order to determine that it is strong enough to accomplish what is expected of it and safe enough to be used upon human beings. Thus the law requires that every batch of serum against diphtheria or lockjaw, every vaccine, every sample of insulin for diabetes, every sample of digitalis or aconite for heart disease, must be tested out upon animals in the laboratory before it is declared safe for use on patients.

Experiments upon animals have taught us the exact causes of many of the diseases that affect our health. It is by experiments upon animals that the remedies for these diseases have been found and made safe and effective; and it is only by experiments upon animals that the diseases, for which no specific remedies have yet been found, will probably be conquered in the future.

BOOK REVIEWS

THE MEDICAL ANNUAL, A YEAR BOOK OF TREATMENT AND PRACTITIONER'S INDEX, 1932. Bristol, John Wright & Sons Ltd., Fiftieth Year, Jubilee Volume.

The fiftieth volume of this famous publication comes to us labeled "Jubilee Volume" and, has, as a special feature, 204 portraits of previous contributors. The volume is sent direct from England with no American agent mentioned. This probably accounts for the inclusion of 150 pages of advertisements which seems to be an English custom. These were formerly eliminated from the American edition. There is also included a list of books and journals which is preponderantly English. The volume is larger than any we have yet seen, and, as usual, quite up-to-date. Each subject is covered by an outstanding authority and a rapid résumé is given of the advances during the year. We have always found this annual a handy reference book for rapid orientation in the more recent advances in medicine. This Jubilee Volume lives up to the reputation of its predecessors; it is well printed, and beautifully illustrated.

YELLOW FEVER, An Epidemiological and Historical Study of Its Place of Origin. By Henry Rose Carter, Late Asst. Surg.-Gen., U. S. P. H. S., Edited by Laura Armistead Carter and Wade Hampton Frost. Balt., Williams & Wilkins Co., 1931.

The book here presented, as planned by Dr. Carter, was to have been a history of yellow fever to the present time but was undertaken when the author was ill. As stated by the editors, "Even this was completed only by working throughout an illness severe enough to confine him to bed for long intervals, and, during his last year, continuously." The editors have done splendidly in taking the author's notes and completing the work approximately as far as he went. Much has been written of the American work on Yellow Fever, particularly the work done by those heroes of science—Reed, Carroll, and H. R. Carter who in 1898 qualified the extrinsic and intrinsic parts of incubation, one of the distinctive advances in the subject to which the last named devoted his life.

This volume is a distinct credit to American medical literature and the editors are to be congratulated upon making the MS available for publication. No student of the history of medicine or of tropical medicine should fail to read and possess this volume.

MEDICINE IN VIRGINIA IN THE EIGHTEENTH CENTURY. By Wyndham B. Blanton, M.D. Richmond, Garrett & Massie, Inc., 1931.

This book is a delightful presentation of source material for the history of medicine in this country. It is bound in a canvas cover decorated with an Indian motif quite in keeping with the contents.

The story of "Medicine in Virginia in the Eighteenth Century" is told in an interesting narrative style. It is interspersed with reproductions of original documents, the title pages of important publications of the time and with portraits of the important medical men of the day. The publication is a typical example of what may be done in the interest of history of medicine if only enough enthusiasm and ability are put into the work. When volumes like this appear about each state in the union, we will have much medical historical Americana to be proud of. Dr. Blanton is to be congratulated upon producing an outstanding book of this kind.

A DESCRIPTION OF THE PLANES OF FASCIA OF THE HUMAN BODY, With Special Reference to The Fascia of the Abdomen, Pelvis and Perineum. By B. B. Gallaudet, M.D., Dept. Anat. College of Physicians and Surgeons, Columbia Univ. N. Y., Columbia Univ. Press, 1931.

This monograph is based on the dissection by the author of thirty-four adult human bodies. In the opinion of the author, the fascial planes are inadequately described in the standard American and English textbooks, and he feels that he has corrected several

anatomical errors which have become imbedded in tradition.

Health for Travelers, Hygiene and Health Preservation in the Tropics, Orient, and Abroad. By the Staff of the Pacific Institute of Tropical Medicine, within the George Williams Hooper Foundation for Medical Research, Univ. of California. Edited by Alfred C. Reed, M.D. San Francisco, J. W. Stacey, Inc., 1931.

This book, published under the auspices of the Pacific Institute of Tropical Medicine, is a splendid handbook to take along on a trip through the Tropics. Health rules are laid down and if the traveler reads this book and follows the rules, it should add to the pleasure and comfort of the trip.

Franz V. Hofmeister's Verbandtechnik. Neu Bearbeitet und Herausgegeben von Dr. Otto Jungling. Ed. 4, Berlin, Urban & Schwarzenberg, 1932.

Hofmeister's work revised by Dr. Otto Jungling is a splendid elementary presentation of the art of bandaging. It is thoroughly complete and up-to-date and of great value to young physicians and surgeons. This work should be translated into English.

The Sign of Babinski, a Study of the Evolution of Cortical Dominance in Primates. By John F. Fulton, M.D., Sterling Prof. of Physiology, Yale Univ. School of Medicine, and Allen D. Keller, M. D., Prof. of Physiology and Pharmacology, School of Medicine, Univ. of Alabama. Springfield, Ill., Charles C. Thomas, 1932.

This book is representative of the highest form of scientific research. It starts off with the first and second pages of Babinski's original paper describing the phenomenon of the toes. For the scientific research worker, it will be found indispensable. The extensive work of Dr. Frederick Tilney on "The Brain from Ape to Man" is well supplemented by Dr. Fulton's monograph and it is to be hoped that many others will follow.

A Text-book of Neuro-anatomy. By Albert Kuntz, Ph.D., M.D. Phila., Lea & Febiger, 1931.

In 350 pages, the author has succeeded in giving the essentials of neuroanatomy. Naturally, this book is not to be compared to the larger works on this subject but it has its definite place as an introduction to the larger and more complete volumes. Many may contend that a little knowledge is a dangerous thing and that the student should either study the entire subject completely or else leave it alone. However if the student is interested, he may want to go further into the subject. With these limitations, therefore, this book has a very definite place and may be recommended.

Der heutige Stand der Knochenbruchbehandlung. Hefte zur Unfallheilkunde. Vol. 2. By Prof. Dr. M. Borchardt. Berlin, F. C. W. Vogel, 1932.

This reprint from the *Monatsschrift für Unfallheilkunde und Versicherungsmedizin*, is a 72 page article detailing the treatment of the more common fractures as it is practiced in Borchardt's clinic. The methods of treatment here detailed are on the whole what might be called conservative measures. The article is well illustrated and will be read with interest by all surgeons interested in the treatment of fractures.

The Intervertebral Discs. By Ormond A. Beadle, M.D. London, H. M. Stationary Office, 1931.

This small monograph is a discussion of the great work of Schmorl, on the pathology of the discs. The author has had an opportunity to study Schmorl's specimens and data in a very thorough manner. The material presented in the monograph represents the results of those observations and constitutes the first extensive account of this work in the English language. The monograph is beautifully illustrated by photographs and photomicrographs.

No one who is interested in manifestations of pathology in the spine should fail to read this exceedingly valuable contribution.

Konstitution und Vererbung in der Orthopädie. By Prof. Dr. B. Valentin. Stuttgart, Ferdinand Enke, 1932.

This is a short article of 30 pages which discusses the constitutional and hereditary

aspects of certain disorders of bones and joints. The paper has nothing particularly new to offer in this way, the subject having been covered more extensively in other monographs in the past.

DIE GESUNDE UND KRANKE WIRBELSÄULE IM RÖNTGENBILD. Pathological-anatomical investigations by Geh. Med.-Rat Prof. Dr. Georg Schmorl. With the roentgenological cooperation of Dr. Med. Herbert Junghanns. Vol. 23, Supplements to the *Fortschritte auf dem Gebiete der Röntgenstrahlen*. Ed. by Prof. Dr. Grashey, Köln. Leipzig, Georg Thieme, 1932.

For a number of years important anatomical researches on the spine have been in progress in the pathological department of the Friedrichstaedter Krankenhaus at Dresden. In 1925 Schmorl began to remove every spine for examination as a post-mortem routine, and during the succeeding five years about 7000 spines have thus been examined by him. Many of them are preserved in the museum. It is stated that the museum contains about 600 complete spines on its shelves; a similar number awaits the time when there will be more room. There is a great wealth of material in small preparations of parts of spines set up by a very durable technique. During these investigations Schmorl has paid attention to many problems of the anatomy and pathology of the spine. New light has been thrown on some questions hitherto unsettled, and particular attention has been given to the intervertebral discs and the articulations of the vertebral bodies. An attempt has been made to connect these changes with important deformities of the spine as a whole, and in particular kyphosis.

The illustrations are numerous and beautifully reproduced. The roentgenographic technique is superlative, but this is explained by the fact that most of the *x*-ray illustrations are of specimens, not of the spine *in vivo*. The teaching value of the work is great. It should be in the hands of every roentgenologist and orthopedist.

DIE DICKDARMSCHLEIMHAUT, IHRE NORMALE UND PATHOLOGISCHE FUNKTION IM RÖNTGENBILDE. (The Mucous Membrane of the Colon; Its Normal and Pathological Function, as Seen Roentgenographically.) By Priv. Doz. Dr. Werner Knothe. Director, Roentgen Dept., Second Medical Univ. Clinic at the Charité, Berlin (Director: Prof. G. v. Bergmann). Leipzig, Georg Thieme, 1932.

The direct anatomical roentgen diagnostic method, by visualization of the mucosa of the alimentary tract, the so-called "relief method," has been applied to all segments of the digestive tube. In this valuable little work the author has sought to study particularly the normal and pathological functions of the colon through alterations in the appearance of the colonic mucosa through this "relief method." The pioneer work of Forssell is taken as the starting point, and from this the author has investigated and correlated the appearances of the colonic mucosa in the normal as well as in the functional and organic diseases of this organ, including neoplasm, non-specific inflammations, tuberculosis, inflammatory changes in the appendix with secondary manifestations in the colon, and the role of the structure of the mucosa in diverticulitis of the large bowel.

To physicians not familiar with this modern trend in roentgen study of the alimentary tube, the illustrations of the normal and pathological mucosal reliefs will be somewhat startling, but the method represents a definite forward step and one which must be adopted into our daily roentgenological practice.

PERIPHERAL NERVE INJURIES

LEWIS J. POLLOCK, M.D., AND LOYAL DAVIS, M.D.

NINTH INSTALLMENT

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Chapter XXVI

THE AXILLARY NERVE

Motor Symptoms

The muscles supplied by the axillary nerve are the teres minor and the deltoid. When they are paralyzed abduction of the hanging arm is impossible. Isolated paralysis of the axillary nerve is rare, but it is commonly observed in brachial plexus lesions. It may result from fracture of the head of the humerus and subglenoid dislocations. It has been observed following prolonged stretching in sleep and anesthesia. A mononeuritis affecting this nerve and tumors are encountered rarely. It was rarely injured alone as the result of war injuries. Purves-Stewart and Bénisty did not observe a single instance. (Figs. 214, 215.)

Supplementary Movements: Satisfactory abduction of the arm when the axillary nerve is completely paralyzed occurs very frequently. The frequency may be seen from the report of Bunts who, in 1903, found that in 19 cases of axillary nerve paralysis 7 patients recovered function. Of the 7, 4 recovered function in the absence of function of the deltoid muscle.

The physiology of the movements of muscles about the shoulder is somewhat complex and current conceptions are obscure in some particulars and controversial in others. Until recently it was the accepted view that in raising the humerus to a straight angle, the deltoid elevates the arm approximately to a right angle, after which elevation is completed by scapular rotation. This view will probably be modified as the result of the investigation of Stookey, who showed that the first cycle of elevation is accomplished by the action of the deltoid and supraspinatus, which raise the humerus to an angle of about 60 degrees. This is accomplished by slight rotation of the scapula. The second cycle is accomplished principally by

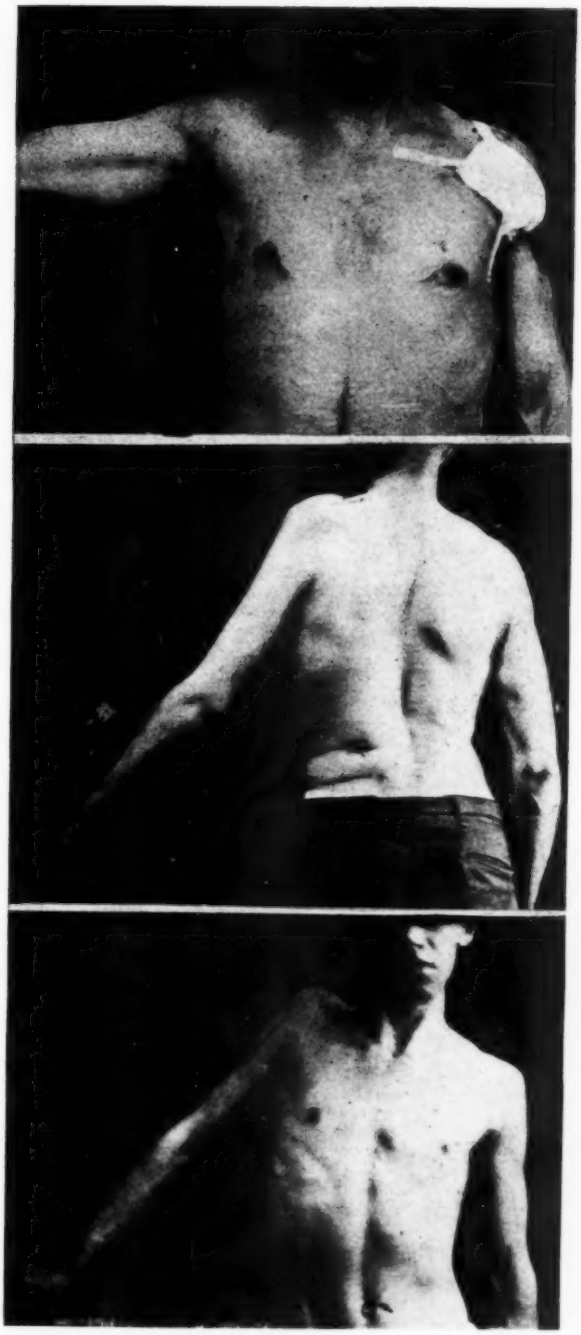

FIG. 214. Attempts to abduct arm in paralysis of axillary nerve.

rotation of the scapula due to the action of the serratus magnus, trapezius, rhomboidei and levator anguli scapulae muscles which raise the arm to an angle of approximately 115 degrees

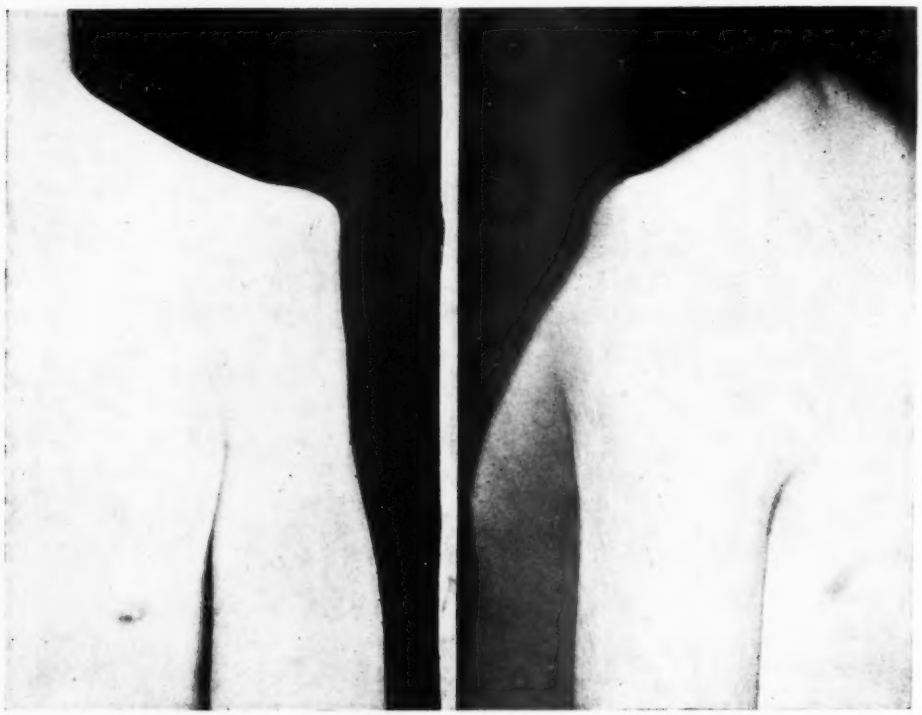

FIG. 215. Atrophy of deltoid muscle in axillary nerve paralysis.

to a straight angle due to the action of the supraspinatus and deltoid muscles. During this movement there is only slight rotation of the scapula. Stookey pointed out that the coracobrachialis and the clavicular head of the pectoralis major were associated with the deltoid in the final stage of elevation.

The importance of the supraspinatus muscle was emphasized by Codman who believed that the deltoid could not act as an abductor of the arm unless accompanied in its action by the supraspinatus whose power furnishes a fulcrum for the action of the deltoid. This view was expressed in part by Winslow, in 1749. As pointed out by Stevens, the subscapularis,

the infraspinatus and the teres minor act as tractors to pull the head of the humerus into the glenoid cavity and fix it firmly. Beyond a certain point, the infraspinatus and teres minor behind and the subscapularis in front may possibly take on an added though limited function; namely, that of abductors as aids of the deltoid.

Duchenne showed in his case of supplementary movements in a deltoid paralysis that it was the supraspinatus, the serratus and the trapezius which supplied the power. Kennedy pointed out in addition the influence of torsion of the vertebral column. Hoffman considered the pectoralis major of prime importance. It is the opinion of Kron that the pectoralis should, with the supraspinatus, pull the head of the humerus into the glenoid cavity while the serratus by rotating the scapula elevates the arm. Loewe attributed the action to the supraspinatus and trapezius.

From studies of clinical cases and preparations of anatomic models, it appears that there are two distinct types of supplementary motility which permit abduction of the humerus in complete paralysis of the deltoid muscle. Of course, the movement of torsion or bending of the spine need not be included since it only increases the distance between the extended hand and the ground and in no way abducts the humerus.

The movement of abduction backward seems never to be supplemented so that such a movement as is necessary to put one's hand in the hip pocket is impossible.

The first type of supplementary movement is that in which the head of the humerus is firmly fixed in the glenoid cavity, probably by the subscapularis, the infraspinatus, the pectoralis major and the supraspinatus muscles. During this period, external rotation of the humerus occurs. The serratus magnus and trapezius, with the rhomboidei and the levator anguli scapulae then produce rotation of the scapula and elevation of the humerus. Some actual abduction may likewise occur. Thus the first and second phases of abduction are combined but the second phase overshadows the first. The third phase may be

concluded by the supraspinatus, the clavicular head of the pectoralis major and the coracobrachialis.

The second type is that in which the first phase of abduc-

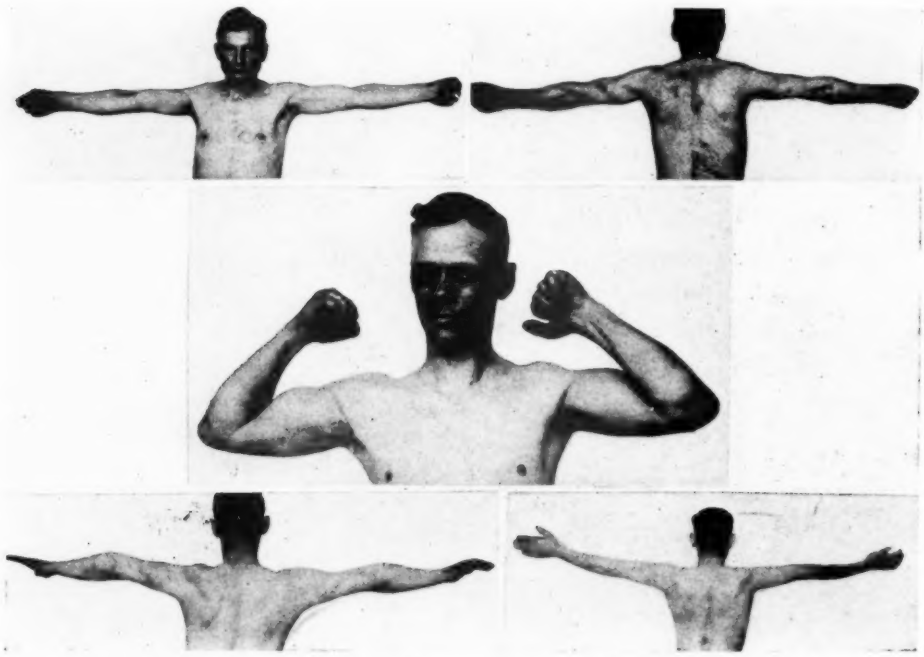

FIG. 216. Supplementary muscle movements in axillary nerve paralysis.

tion of the humerus may occur as the result of combined action of the supraspinatus, the infraspinatus acting simultaneously with the coracobrachialis and possibly the long head of the biceps. The second phase of abduction occurs as in the normal individual, by the action of the serratus magnus, the trapezius, the rhomboidei and the levator anguli scapulae. The third phase is completed by the coracobrachialis, the clavicular head of the pectoralis major and the supraspinatus. (Fig. 216.)

SENSORY SYMPTOMS

The sensory loss occupies an area on the outer side of the arm and shoulder cap corresponding closely to the distribution of the fifth cervical root. Frequently but little loss of pain

sense is found in this area. When injured with the musculocutaneous nerve, recovery commonly occurs first in the axillary nerve. (Fig. 217.)

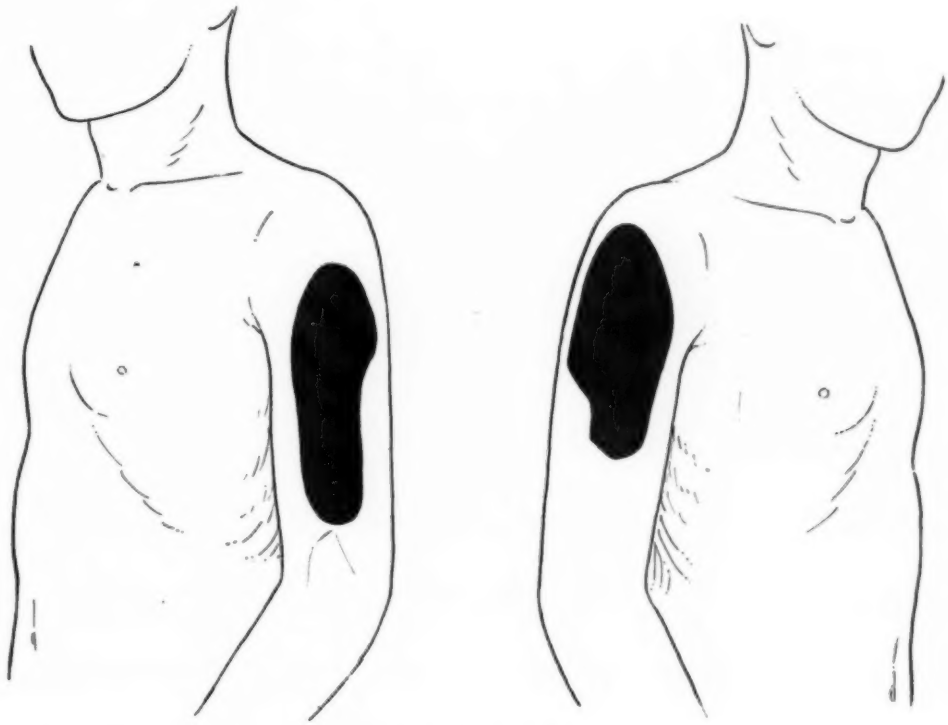

FIG. 217. Sensory loss in axillary nerve paralysis.

ANATOMY

The axillary nerve arises from the posterior cord of the brachial plexus. The posterior divisions of the fifth and sixth cervical spinal nerves supply fibers to make up its trunk. Its origin is occasionally behind the pectoralis minor, rarely below the inferior border of this muscle and always posterior to the axillary artery. The nerve may leave the posterior cord of the plexus anterior, external or internal to the radial so that there may be very many variations in its mode of origin. The nerve descends upon the subscapular muscle to enter the

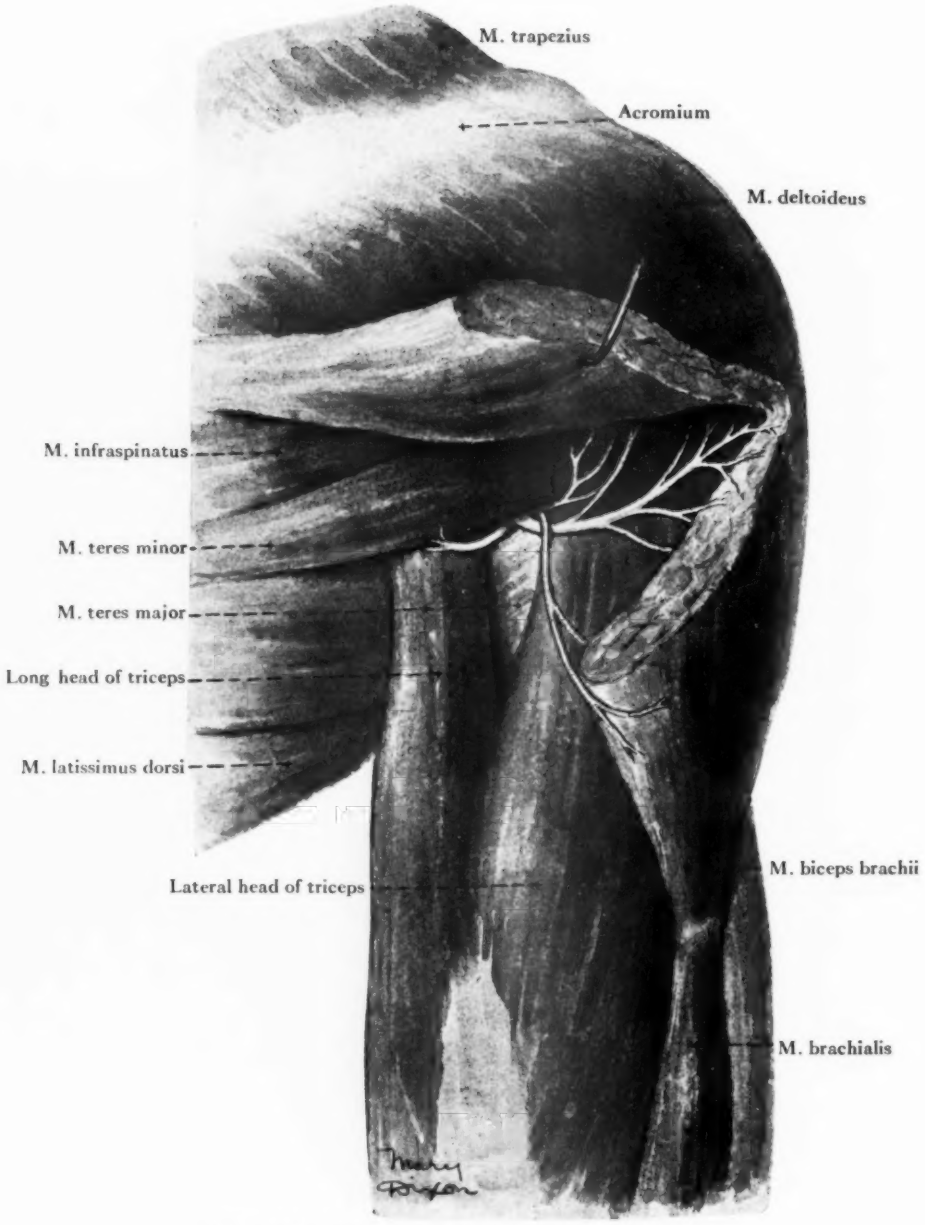

FIG. 218. Anatomical course of axillary nerve.

quadrilateral space. It then turns about the posterior and external surface of the surgical neck of the humerus to end within the deltoid muscle. (Fig. 218.)

In the axilla as it lies upon the subscapular muscle it is hidden behind the axillary artery. The posterior circumflex artery and vein, which lie above the nerve, accompany it to enter the quadrilateral space which is formed by the teres minor and subscapularis muscles above, the latissimus dorsi below, the long head of the biceps laterally and the humerus medially. Of all the branches of the brachial plexus in the axilla, the radial is the only nerve in close relation to the axillary. The other nerves lie on a more anterior plane.

As the nerve passes obliquely and externally through the quadrilateral space it lies close to the inferior part of the capsule of the shoulder joint. Leaving this space the nerve, still accompanied by the posterior circumflex artery, wraps itself from behind forward about the surgical neck of the humerus. It is separated from the bone by a strong aponeurosis of the deltoid muscle.

A small ramus from the axillary nerve is distributed to the marginal portion of the subscapularis muscle. According to Rudinger two branches supply the shoulder joint. The superior ramus arises within the axilla and supplies the anterior part of the joint capsule while the inferior twig which arises within the quadrilateral space is distributed to the inferior part of the capsule.

The *branch to the teres minor muscle* is of considerable size and arises as the axillary leaves the quadrilateral space. It then has a recurrent course upward and anteriorly to reach the muscle into which it disappears by numerous filaments.

The *cutaneous branch* of the axillary arises from the branch to the teres minor and occasionally forms a common trunk with it. The nerve perforates the superficial aponeurosis at the posterior edge of the deltoid muscle. As it becomes superficial it divides into innumerable terminations, which ramify within the skin. Some of these twigs anastomose with branches of the

internal cutaneous nerve of the arm to supply the skin over the deltoid area.

The *terminal* branches, two in number, end within the deltoid muscle. The posterior terminal is shorter and may arise from the branch to the teres minor. It is distributed to the spinal portion of the deltoid. The anterior branch is longer and supplies the anterior fibers as well as the acromial and clavicular fibers of the deltoid. Some of the twigs traverse the muscle completely and become cutaneous where they anastomose with the ramifications of the cutaneous branch of the axillary.

Physiology

The *teres minor* muscle has an analagous action to the infraspinatus. It rotates the head of the humerus outward.

The *deltoid* muscle abducts the arm from the side to a right angle with the trunk. As it performs this function the vertebral border of the scapula stands out from the wall of the thorax. If the arm is abducted vigorously all of the fibers of the deltoid contract. When the arm is drawn forward or inward the posterior fibers relax.

Surgery

Isolated lesions of the axillary nerve are comparatively rare so that the nerve is usually affected by injuries to the upper part of the brachial plexus. Because of its short course, its repair is quite difficult and in the event of a continuity defect an end-to-end suture is practically impossible. Dislocations of the shoulder, particularly those which are anterior and inferior in direction may seriously traumatize the nerve.

If the nerve is injured in the axilla surgical exposure is obtained in much the same manner as in lesions of the plexus. The arm is strongly abducted and rotated outward. An incision is made over the course of the neurovascular bundle from the middle of the clavicle to the tendon of the pectoralis major muscle (Fig. 219). The deltoid and pectoralis major are

separated and the pectoralis major fascia is exposed. The tendon of the latter muscle may then be retracted. The deep pectoral fascia is divided to expose the neurovascular bundles.

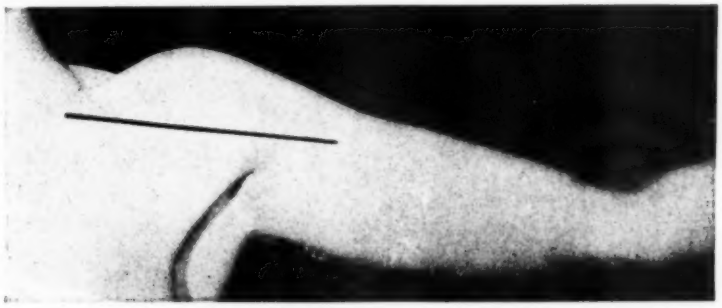

FIG. 219. Line of incision to expose axillary nerve.

The median nerve and axillary artery are identified and retracted medially. This will expose the radial nerve as it passes over the tendon of the latissimus dorsi. This nerve should be followed upward and near the insertion of the pectoralis minor muscle, the axillary nerve will be found in close relation to the radial. The axillary may then be traced around the medial side of the neck of the humerus to the point where it enters the quadrilateral space.

If the axillary nerve is injured as it passes around the surgical neck of the humerus, a dorsal or laterally placed incision is necessary for an exposure. The patient should lie upon his side with the arm acutely flexed. This will afford access to the posterior deltoid region. A longitudinal incision should be made along the dorsal border of the deltoid muscle. The muscle should be elevated and retracted anteriorly. This procedure may be facilitated by elevating the arm so that the deltoid is relaxed. Occasionally it may be necessary to divide some of the deltoid fibers to isolate the nerve as it emerges from the quadrilateral space to wind about the neck of the humerus.

Chapter XXVII

THE MUSCULOCUTANEOUS NERVE

The musculocutaneous nerve is rarely injured alone by gunshot or stab wounds. It is commonly involved in brachial plexus lesions. Paralysis may likewise result from concomitant fracture of the humerus and callus formation. It has been observed after dislocation of the humerus. Occasionally it has been the seat of a mononeuritis.

Motor Symptoms

Evidence of paralysis of this nerve may be determined by palpation of the biceps muscle when flexion of the forearm is resisted with the forearm in position between pronation and supination (Fig. 220). It may be detected also by observing absence of normal contraction of the biceps upon voluntary movements and its failure to contract to the faradic current.

Supplementary Movements: Although supplementary motility permits of all the movements ordinarily assisted in by the muscles supplied by the musculocutaneous nerve, they are naturally reduced in strength. The biceps supinates as well as flexes the forearm, while the brachialis anticus is a pure flexor. In paralysis of the musculocutaneous satisfactory flexion can be produced by the voluntary action of the brachioradialis which is supplied by the radial nerve. The pronator radii teres is also a flexor of the forearm and in some cases has efficiently produced flexion in combined paralysis of the musculocutaneous and radial nerves.

Sensory Symptoms

The sensory loss is observed over the radial side of the volar surface of the forearm (Fig. 221). At times the loss to tactile sensibility is wide, yet because of overlap from the medial cutaneous and radial nerves there is a considerable zone within the borders of this area where pain is felt.

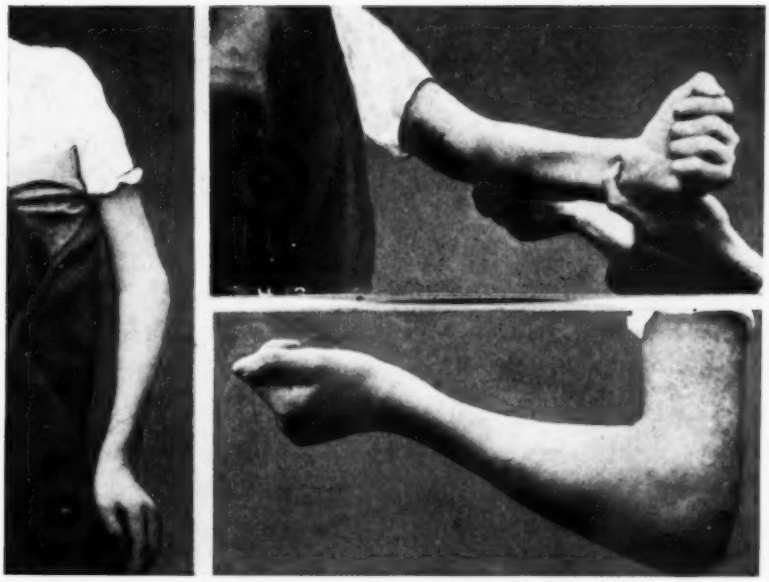

FIG. 220. Paralysis of the biceps muscle in musculocutaneous nerve paralysis.

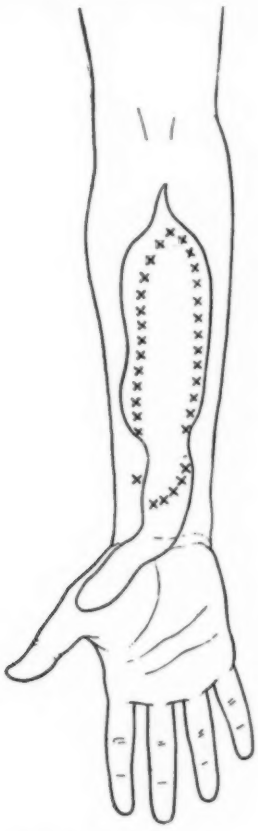

FIG. 221. Sensory loss in musculocutaneous nerve lesion.

Signs of Recovery

Recovery appears in all the muscles simultaneously, and sensory regeneration goes hand in hand with motor.

Anatomy

The musculocutaneous nerve arises from the lateral cord of the brachial plexus. Therefore, it receives fibers from the anterior divisions of the fifth and sixth cervical spinal nerves. It has an origin in common with the lateral head of the median nerve. With the exception of the medial cutaneous nerves to the arm and forearm it is the smallest terminal branch of the brachial plexus. At its origin it is in contact with the axillary artery but soon descends externally and anteriorly, leaving the neurovascular bundle medial and posterior to it. The nerve perforates the coracobrachialis muscle between its two heads and then lies between the brachialis anticus and biceps muscles. It reaches the external bicipital groove, pierces the aponeurosis and divides into its two terminal branches which course along the radial surface of the forearm to end on the dorsal surface of the wrist at the base of the thenar eminence.

The musculocutaneous arises from the brachial plexus beneath the pectoralis minor muscle though it may arise more peripherally, almost as a branch of the median. It lies anterior to the subscapularis muscle and parallels the lateral border of the third portion of the axillary artery. The lateral head of the median nerve lies upon the artery and the other branches of the plexus lie anterior to the musculocutaneous. As the latter leaves the vessel it crosses the circumflex vessels, and pierces the coracobrachialis in an oblique canal formed by the two heads of origin of the muscle. The canal is at the level of the tendon of the latissimus dorsi. Occasionally the musculocutaneous may not lie in this canal but may pass either external

or medial to the muscle. After passing between the brachialis anticus and biceps to reach the external bicipital groove it penetrates the aponeurosis at a variable point above the elbow. Regardless of this exact site the nerve becomes subcutaneous medial to the cephalic vein. It divides into its terminal cutaneous branches at this level, where it may also anastomose with the external cutaneous branch of the radial, which perforates the aponeurosis external to the cephalic vein (Fig. 222).

Just below the origin of the nerve it gives off *periosteal rami* which supply the humerus.

Vascular branches, variable in number, supply the walls of the inferior part of the axillary and all of the branchial artery. Exceptionally the nerve may give twigs to the beginning of the radial artery.

As the musculocutaneous enters the canal between the two heads of origin of the *coracobrachialis* muscle it gives off a branch to that muscle. Though this branch runs directly with the musculocutaneous and usually is incorporated within its sheath, it is actually a distinct nerve. It receives its fibers from the anterior divisions of the seventh cervical spinal nerve.

Many times each head of the *biceps* receives two or three twigs which originate directly from the trunk of the musculocutaneous, but more often these various twigs arise within a common trunk which may appear to be a bifurcation of the musculocutaneous. This trunk may arise from the musculocutaneous as it descends obliquely between the biceps and branchialis anticus. After a short course the trunk then divides into two branches whose ramifications form a plexus. One of these branches supplies the long head and another the short head of the biceps at a level just below the middle of the arm.

The nerves to the *brachialis anticus* may be four or five in number, which arise from the musculocutaneous by a common trunk.

A small articular *ramus to the elbow joint* may be given off either from the branch to the biceps or from that to the

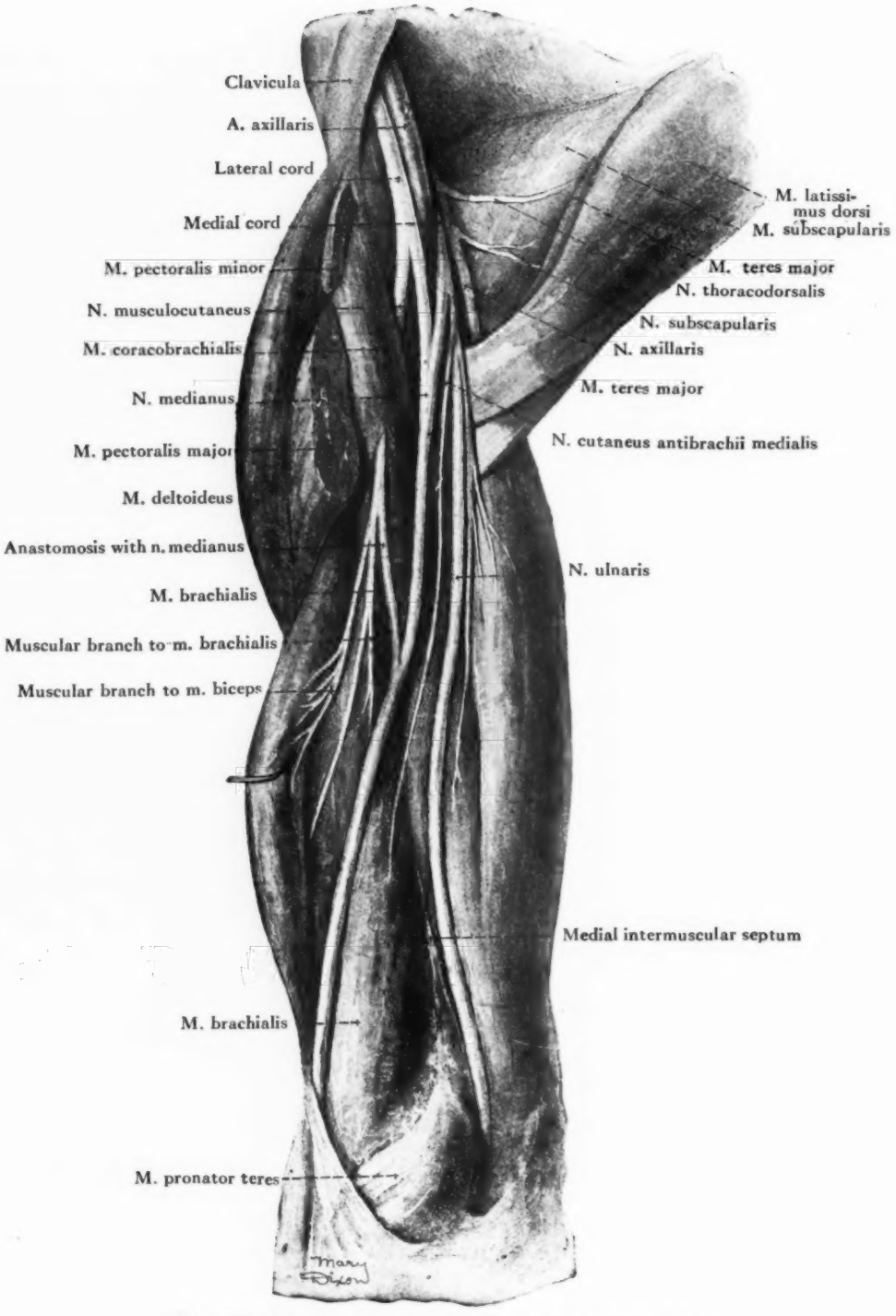

FIG. 222. Anatomical course of musculocutaneous nerve.

brachialis anticus. This articular ramus supplies the medial part of the anterior surface of the capsule of the joint.

The terminal branches of the musculocutaneous are entirely cutaneous in function. Of these two branches, one lies anterior and medial while the other is posterior and lateral. As they descend in the forearm they cross the medial cephalic vein. Occasionally one branch may lie anterior and the other posterior to the vein.

The anterior and medial branch is the larger of the two and courses along the anterior surface of the radial half of the forearm. In its course it gives off many collateral branches at an acute angle, which pass across the median line and anastomose with collaterals from the internal cutaneous nerve to the forearm. Other collaterals pass laterally to anastomose with twigs from the posterior and lateral branch. The anterior and medial cutaneous branch ends by supplying the skin over the thenar eminence. The posterior and lateral cutaneous branch descends upon the lateral side of the posterior surface of the forearm. It terminates on the dorsal surface of the inferior part of the forearm in the region of the anatomical snuff-box.

Many types of anastomosis and anomalies of distribution occur between the median and musculocutaneous nerves. As was pointed out, the origin of the lateral head of the median and the musculocutaneous is the same. It is only in higher mammals that the two nerves are not represented by a single trunk. In man the median nerve may take over the entire motor and sensory supply of the musculocutaneous.

Some type of communication between the two nerves occurs in about 7 per cent and the variations may depend upon the type of brachial plexus; that is, whether it is prefixed or postfixed. Stookey states that fibers pass from the musculocutaneous to the median nerve more often in the postfixed plexus, perhaps because the fifth and sixth cervical roots contribute less to the median nerve than they do in the prefixed plexus. In the latter type of plexus the communication may be reversed.

Physiology

The *coracobrachialis* muscle keeps the head of the humerus firmly within the glenoid cavity as the arm is lowered. An isolated paralysis of this muscle is difficult to detect.

The *brachialis anticus* produces forceful flexion of the forearm without any other movement. It is therefore an independent flexor of the forearm.

The biceps flexes and supinates the forearm. According to Duchenne the movement of supination is due rather to the short than to the long head of the biceps.

Surgery

In the upper part of its course lesions of the musculocutaneous are usually associated with injury to the neurovascular bundle. If the nerve is injured in the lower third of the arm, the motor fibers usually escape involvement.

In the axilla the nerve may be exposed by a long incision which follows the medial border of the coracobrachialis muscle. It begins a few centimeters below the clavicle and extends to the middle of the arm. The coracobrachialis is exposed by division of the deep fascia. The pectoralis major and deltoid are separated and the deep pectoral fascia is exposed. The cephalic vein should be preserved in this situation. The pectoralis major tendon should be divided and retracted medially. The median nerve may be isolated by dividing the pectoral fascia covering the neurovascular bundle. The median should be followed upward and its lateral and medial heads identified. The musculocutaneous may then be isolated as it lies lateral to the median's external head and before it enters the canal in the coracobrachialis muscle.

A lesion to the nerve below the coracobrachialis is exposed by a longitudinal incision over the upper portion of the biceps. The two heads of this muscle should be separated. In this recess the nerve will be found as it lies on the coracobrachialis.

Occasionally certain lesions necessitate exposure of the cutaneous terminal branches of the nerve and often it is utilized for an autogenous graft. The incision extends along the medial edge of the brachioradialis muscle. The nerve will be found emerging from beneath the lateral edge of the biceps. It may be followed upward by retracting the biceps medially. Continuity defects in the musculocutaneus may be partly overcome by flexion and adduction of the arm. If the pectoralis major tendon has been divided it should be carefully sutured and the arm maintained in flexion and adduction.

Chapter XXVIII

SHOULDER GIRDLE NERVES

The long thoracic is a purely motor nerve and supplies the serratus magnus muscle. In civil practice paralysis of this nerve is commonly observed as an isolated lesion, but it also occurs frequently in association with paralysis of the trapezius, rhomboids, spinati and other muscles. It occurs more frequently in men, usually laborers, and in muscular individuals between the ages of twenty-five to forty-five years. The right side is most frequently affected, and it is usually injured unilaterally. The injury occurs as a result of trauma from the strain of prolonged and excessive use of the muscle in carrying heavy weights, or the use of a hammer; from continued elevation of the arms, as in painting, cleaning walls and from direct injury from puncture or gunshot wounds. The nerve may be injured during the extirpation of diseased glands and other operative procedures. Mononeuritis has often been described as affecting this nerve. In the war a few cases of isolated paralysis were described.

Contraction of the serratus magnus muscle results in carrying the scapula forward, outward and upward. It contracts vigorously in conjunction with the pectoralis major in the act of pushing the point of the shoulder forward. Its action in supplementing the deltoid in abduction of the arm has been described.

When paralyzed, the position of the scapula when at rest is not abnormal. Upon attempting to raise the arm to the horizontal there is a characteristic "winging" of the scapula (Fig. 223). The anterior aspect of the scapula leaves the thorax and the vertebral borders stand away prominently from the middle line. Although it is an important muscle in abduction of the arm, according to Steiner who, in 1900, analyzed the cases which occurred in the German army, the remaining

intact muscles are sufficient to permit abduction of the arm above a right angle in 95 per cent of the cases. Complete elevation of the arm to 180 degrees was, however, defective.

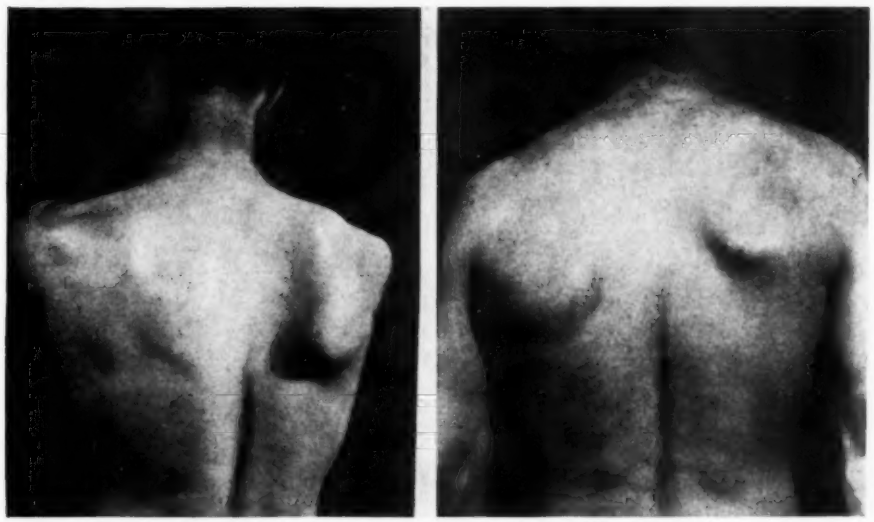

FIG. 223. Deformity of "winged" scapula in serratus muscle paralysis.

In a certain number of cases the arm can not be elevated much above the right angle unless the scapula is passively immobilized against the chest wall.

The other nerves which supply the muscles of the shoulder girdle, dorsalis scapulae (rhomboids and levator anguli scapulae); the anterior thoracic nerves (pectoralis major and minor); suprascapular (supraspinatus and infraspinatus); subscapularis (subscapular); and the thoracodorsalis (latissimus dorsi) are injured alone so rarely that their function only will be described so that when their injury is noted in the chapter on brachial plexus lesions the resulting disability may be understood.

The dorsalis scapulae nerve supplies the rhomboids and the levator anguli scapulae. The former muscles hold the scapula upward toward the midline, approximating the inferior angle to the vertebral column, while the internal angle is drawn away from it. When the shoulder is raised energetically the

rhomboid comes into active function. When paralyzed, the groove between the scapula and the chest wall becomes deeper and it is difficult to draw the arm backward and out-

FIG. 224. Paralysis of rhomboids and infraspinatus muscles.

ward (Fig. 224). The levator anguli scapuli raises and rotates the superior angle of the scapula inward, drawing the point of the shoulder with it. It contracts forcibly on coughing, and its paralysis may readily be ascertained by its failure to contract during that act.

When both latissimi dorsi muscles contract the shoulders take the position of a soldier at attention. Their function may be tested by having the patient place his hand as if in a hip

pocket on the affected side, and to resist attempts to draw the arm forward.

The anterior thoracic nerves supply the pectorals which, when contracted, adduct and bring the arm forward. The upper portion draws the point of the shoulder upward and forward. With the arm in a vertical position it draws the shoulder forward toward the midline and depresses it to the horizontal. Attempts passively to abduct the adducted upper extremity in a horizontal position produce a contraction of the muscles which may readily be felt and seen.

The anatomy, physiology and surgery of these nerves, which are collateral branches which arise from the constituent roots of the brachial plexus before the lateral, medial and posterior cords are formed will be described in the following chapter upon the brachial plexus.

Chapter XXIX

THE BRACHIAL PLEXUS

We have become accustomed to a simple classification of brachial plexus lesions in civil practice. This has been possible because the majority of injuries, occurring either as the result of trauma at birth or trauma produced by dislocation of the humerus and traction of the plexus, have produced lesions of certain parts of the plexus in a constant manner peculiar to the particular injury. Such injuries have been classified as complete and incomplete. Of the incomplete forms the upper brachial plexus paralysis, or Erb's palsy, has been the most frequent. This is produced by a lesion of the fifth and sixth cervical roots, and results in a paralysis of the deltoid, biceps, brachialis anticus, brachioradialis, occasionally the supinator brevis and the infraspinatus and, less frequently, the subscapularis muscles (Fig. 225). Klumpke's palsy, or lower brachial plexus paralysis, has been found less frequently. This results from a lesion of the eighth cervical and first dorsal roots and produces a paralysis of the muscles supplied by the ulnar nerve and the inner head of the median nerve (Fig. 226).

Lesions of the secondary cords have been encountered far less frequently. Injury to the outer cord of the plexus produces a paralysis of the muscles supplied by the musculocutaneous nerve and the outer head of the median. Injury of the posterior cord results in paralysis of the muscles supplied by the radial and axillary nerves, and injury to the inner cord results in paralysis of the muscles supplied by the ulnar and the inner head of the median nerve. There is a temptation and tendency to ignore that which does not fit in with a preconceived and accepted simple classification. Even in civil practice, it is common to find a lesion at first affecting the whole brachial plexus which later resolves itself into a more or less permanent injury to a part of the plexus (Fig. 227).

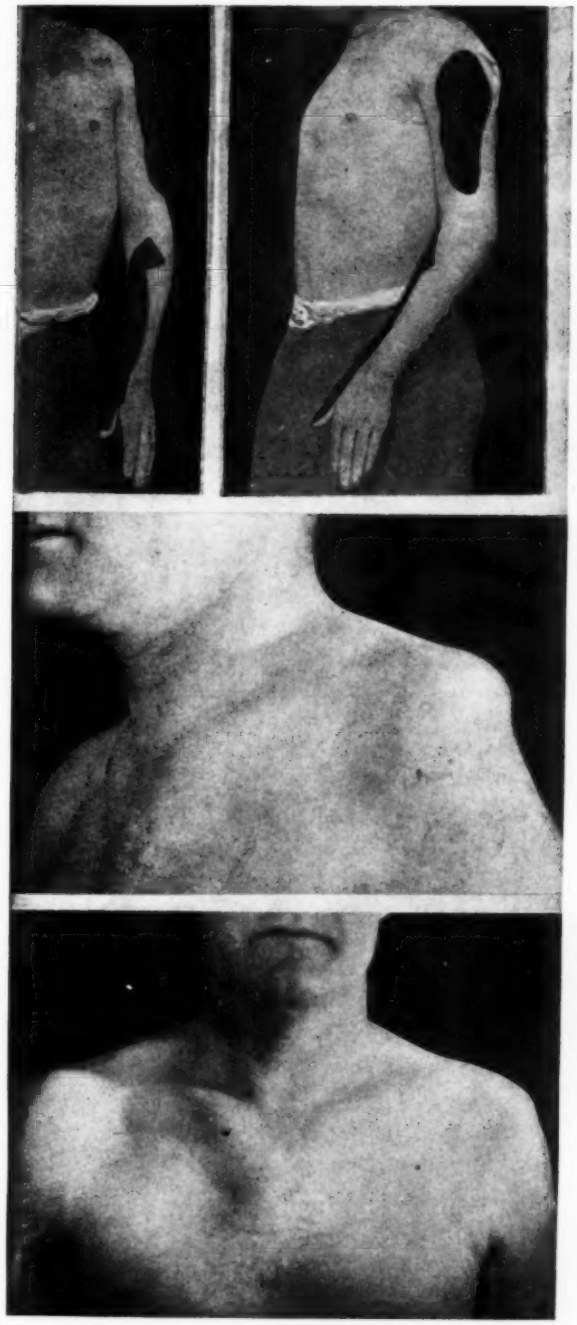

FIG. 225. Upper brachial plexus paralysis.

In civil practice injury to the brachial plexus may occur in operative procedures upon the neck and axilla, and anesthetic and sleep palsy have been observed. However, more frequently

FIG. 226. Lower brachial plexus paralysis.

it is injured at birth. Dislocation and fracture of the humerus; pressure of the heel in the axilla in reducing dislocations; direct

violence in the posterior cervical triangle; cervical ribs; osteoarthritis of the spine; and compression by tumors may produce paralysis. Sudden strong abduction of the arm and force

FIG. 227. Residual paralysis following partial lesion of entire brachial plexus.

transmitted to an outstretched arm, as well as traction on a hanging arm, may also injure it.

Gunshot injuries of the brachial plexus occurred in large numbers in the late war. The statistics vary considerably. Purves-Stewart found 61 such cases, or 19 per cent, in 318 peripheral nerve injuries. Lehmann found 37, or 7.5 per cent, in 494 peripheral nerve injuries. Oppenheim in a series of 1612 cases found 84, or 5 per cent. In our series of 1020 cases, there were 79, or 7.7 per cent.

Inasmuch as the lesions of the brachial plexus which result from gunshot injuries have a tendency to recover spontaneously, there is considerable difference in incidence between the observations at the front and those in general hospitals where the material is seen some time after injury.

In military practice, injuries to the brachial plexus do not lend themselves so readily to a simple classification. Gunshot wounds produce injuries the extent of which is dependent upon the course of each particular missile and are so variable that there may be a lesion of roots, and primary or secondary cords, in a single case. Furthermore, the initial trauma is followed by changes secondary to hemorrhage, infection and fibrosis. In addition to variable injuries, the numerous and wide variations in the formation of the brachial plexus, as described by Borchardt, are responsible for atypical paralyses.

Anatomically the lesions may be grouped into supraclavicular and infraclavicular. It is striking that in 23 available and competent records of 44 cases seen in base hospitals in France, all were supraclavicular. This is in part explained by the fact that infraclavicular lesions, commonly due to injuries in the axilla, were complicated by injuries to bones and vessels which made the neurological aspect less urgent, and because of the necessary splints and dressings frequently led to misinterpretations. For example, a diagnosis of a combined ulnar and median nerve lesion was usual instead of a lower brachial plexus lesion.

In a series of 35 cases observed in a general hospital a number of months after injury, there were 22 infraclavicular and 13 supraclavicular lesions. In the overseas cases there were only 3 lower plexus injuries; in those seen in the United States there were 12. Inasmuch as it has been found that lesions of the lower plexus are more frequently irrecoverable, the explanation is apparent.

Although it has been stated (Souttar) that supraclavicular and infraclavicular lesions produce injury of the roots and cords respectively this was not found to be true. However, supraclavicular injuries apparently produce lower brachial lesions but rarely. An upper brachial lesion is most commonly produced, although middle plexus lesions occur frequently. Infraclavicular injuries produce lower plexus paralysis most frequently, but middle plexus paralysis is likewise common.

The cases may be most readily grouped into those which show an upper, middle or lower plexus paralysis. The upper plexus paralysis includes lesions of the fifth cervical nerve; the upper primary trunk (fifth and sixth cervical); and a combination of the upper primary trunk and a diffuse lesion of the middle plexus. The middle plexus lesions are produced by injury to the posterior branches alone (radial and axillary); to the posterior secondary cord or to the posterior and outer cord. In lower plexus paralysis there may be a lesion of the inner secondary cord alone, or combined with a partial middle plexus lesion; or of the peripheral nerves, usually at a level below the complete formation of the median nerve but at times above that point. Finally, there may be an incomplete paralysis of the entire brachial plexus.

Motor Symptoms

The complexity of the symptomatology may be seen from this far from simple classification. This complexity is better illustrated by diagrammatic representations of brachial plexus lesions which frequently show the impossibility of correlating the motor loss to any single lesion and lead only to an approximation of a localization. Operative exploration verifies the conclusion that although the greater part of an injury may be at one location, diffuse lesions occur elsewhere as well.

It has been found useful to employ diagrammatic representation of the location of an injury as described by Meige (Fig. 228). Two cases of upper brachial plexus lesions, due to injury of the fifth cervical nerve, are illustrated in Figure 229 and 230. Figure 229 represents the location of a lesion in a soldier who had a paralysis of the deltoid muscle and a paresis of the spinati and triceps muscles. Figure 230 is a diagram of the lesion which produced a paralysis of the deltoid muscle and a weakness of the spinati, pectoralis, latissimus dorsi, coracobrachialis, biceps and supinators.

Two other cases of upper brachial plexus lesions produced by an injury of the upper primary trunk are shown in Figures

231 and 232. In the case in Figure 231 there was a paralysis of the deltoid, spinati, biceps and brachialis anticus and a weakness in the subscapularis, supinators and the extensors

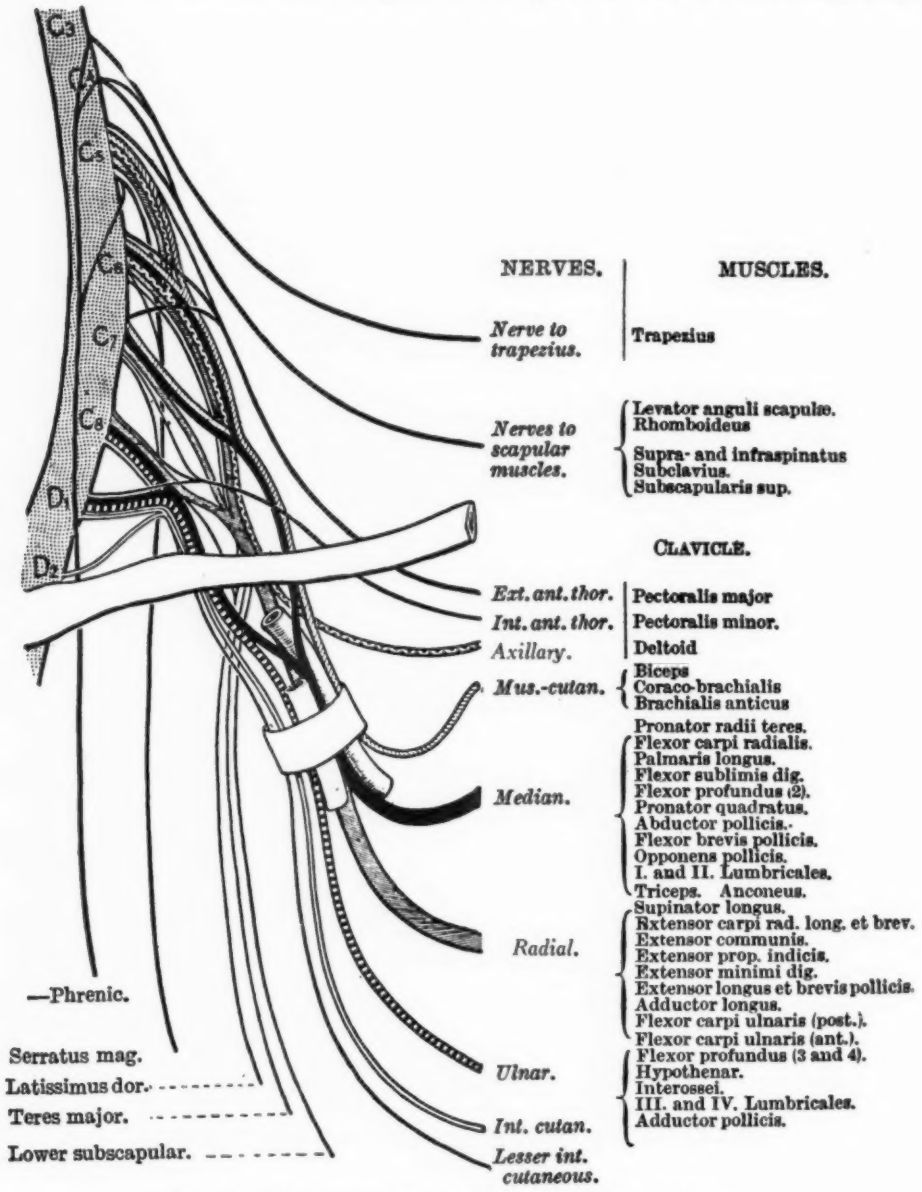

FIG. 228. Diagram of brachial plexus. (After Meige.)

of the wrist. In Figure 232 the lesion is not as clearly defined and there was found a paralysis in the deltoid and spinati and

a weakness in the pectoralis, triceps, biceps, brachialis anticus, supinators and extensors of the wrists and fingers.

Two other cases of upper brachial plexus lesions of a more

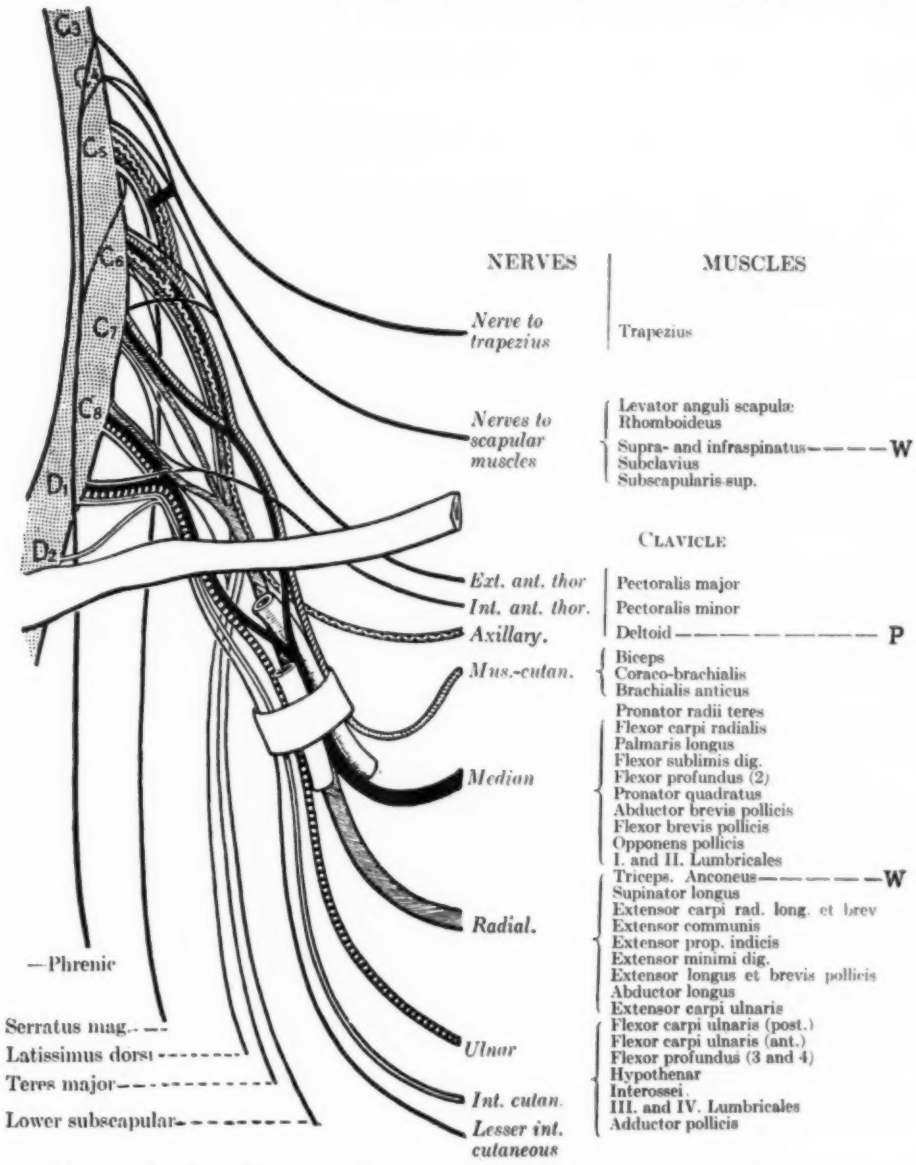

FIG. 229. Lesion of brachial plexus, described in text. W, weak. P, paralyzed.

complicated nature are illustrated in Figure 233 which represents the location of a lesion producing a paralysis of the

biceps, brachialis anticus, supinators and extensors of the wrists and fingers, and a weakness of the deltoid, spinati and triceps. In this instance there was an incomplete lesion of the

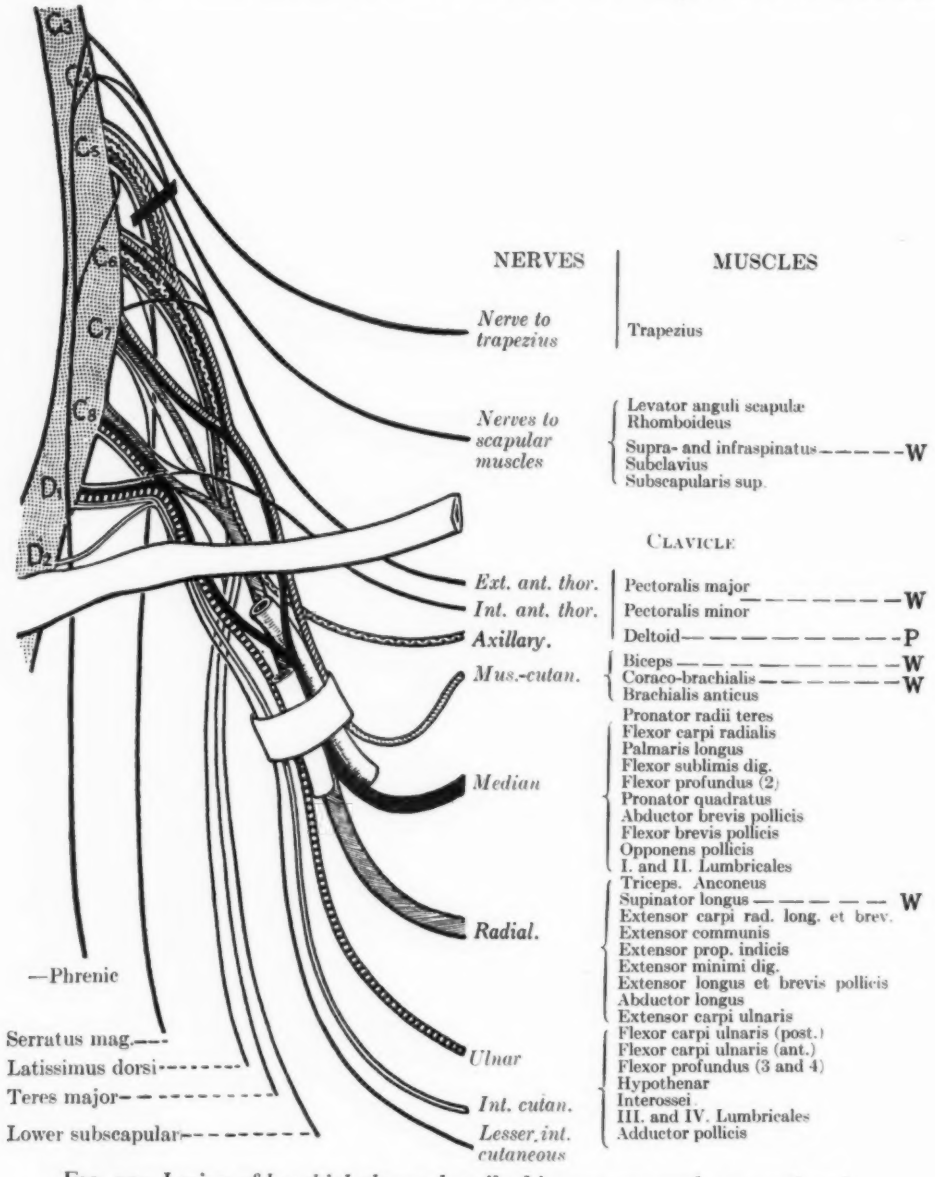

FIG. 230. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

upper primary cord and a more severe one of the middle plexus. Figure 231 represents a case in which the upper plexus

was more severely injured and there resulted a paralysis of the deltoid, spinati, biceps, brachialis anticus, triceps, extensors of the wrist and fingers, supinators and pronators, flexor

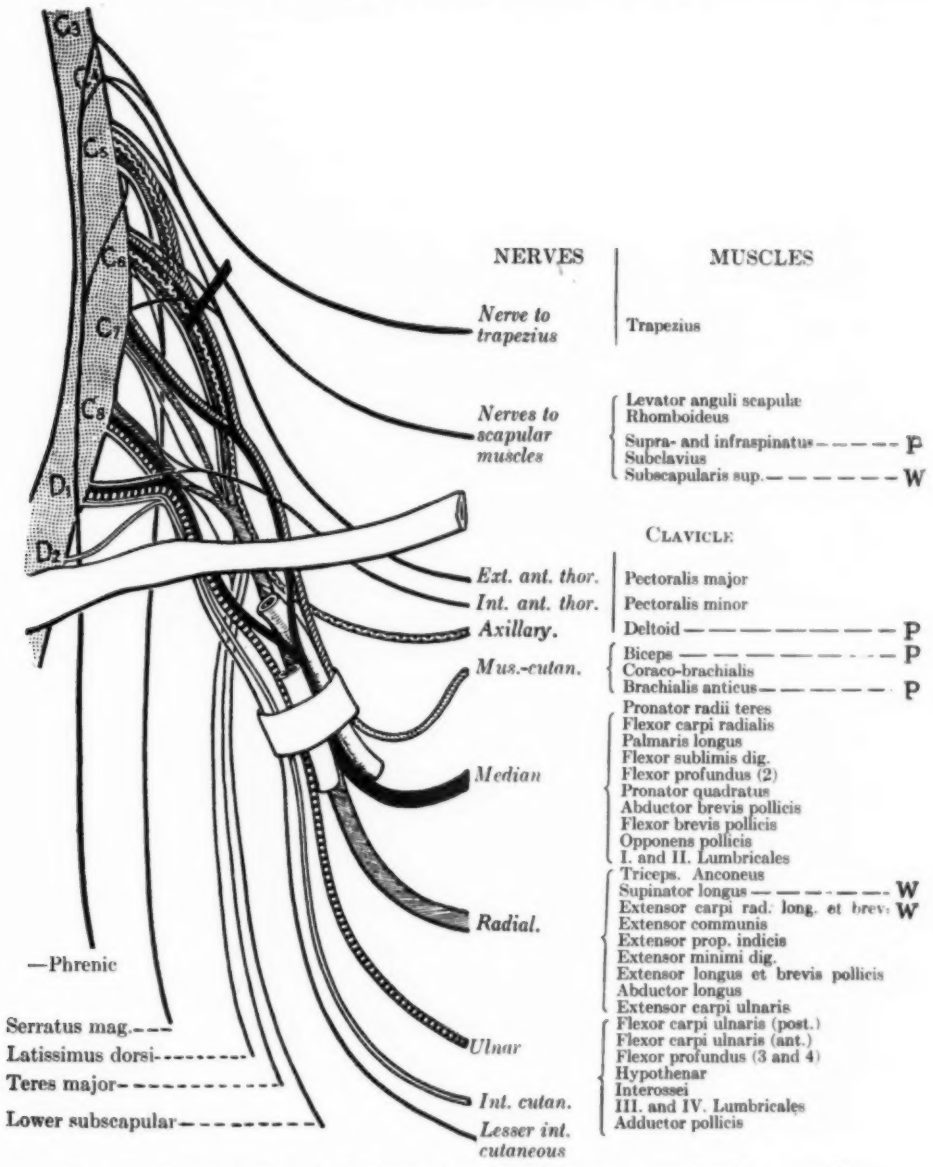

FIG. 231. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

longus pollicis, and a weakness of the flexor carpi radialis and opponens pollicis.

Although for practical purposes the foregoing cases could be divided into lesions of the cervical nerves, the upper primary cord and a combination of the upper primary cord and the

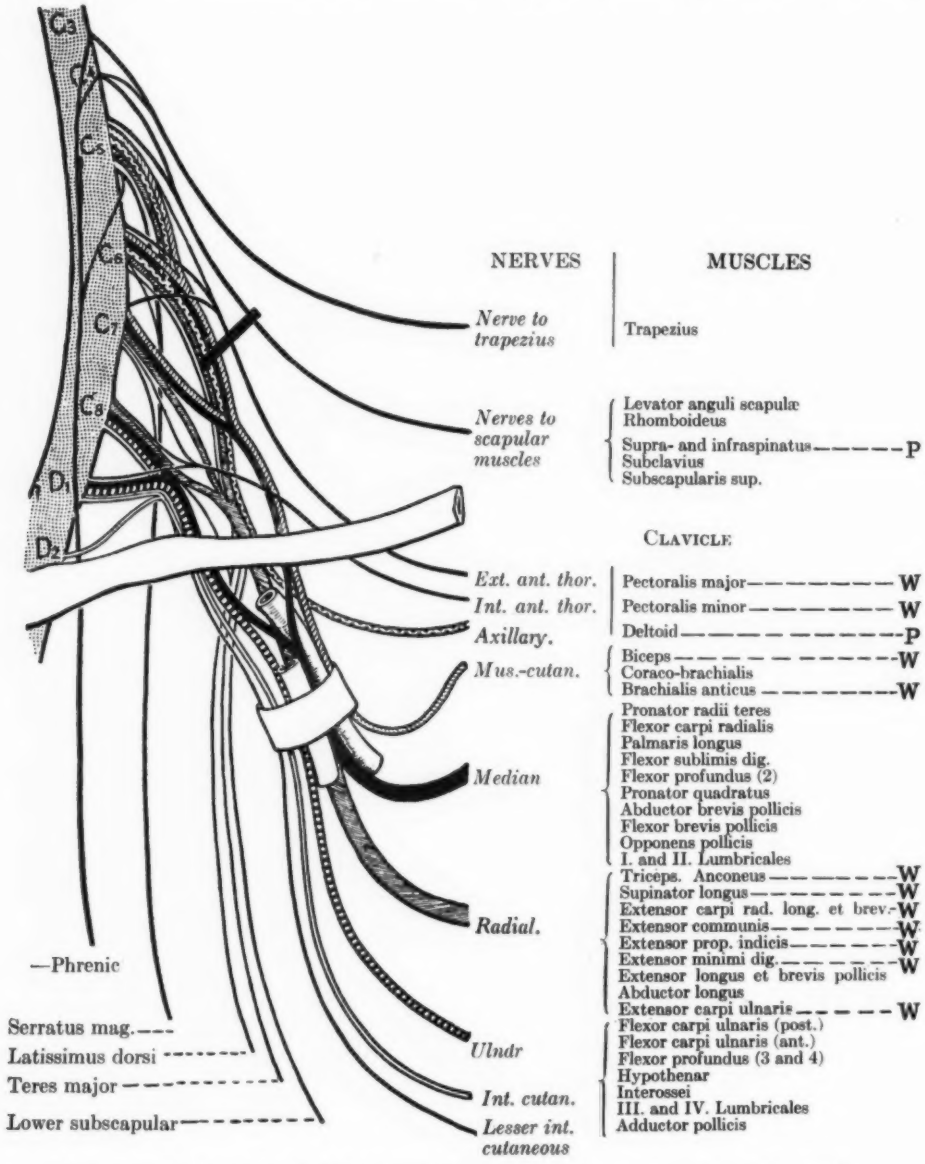

FIG. 232. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

middle plexus, it is apparent that none of the cases accurately corresponds to such a classification.

In contrast to the material of Oppenheim, few cases of relatively pure middle plexus lesions were seen. Frequently a severe lesion of the middle plexus was found combined with

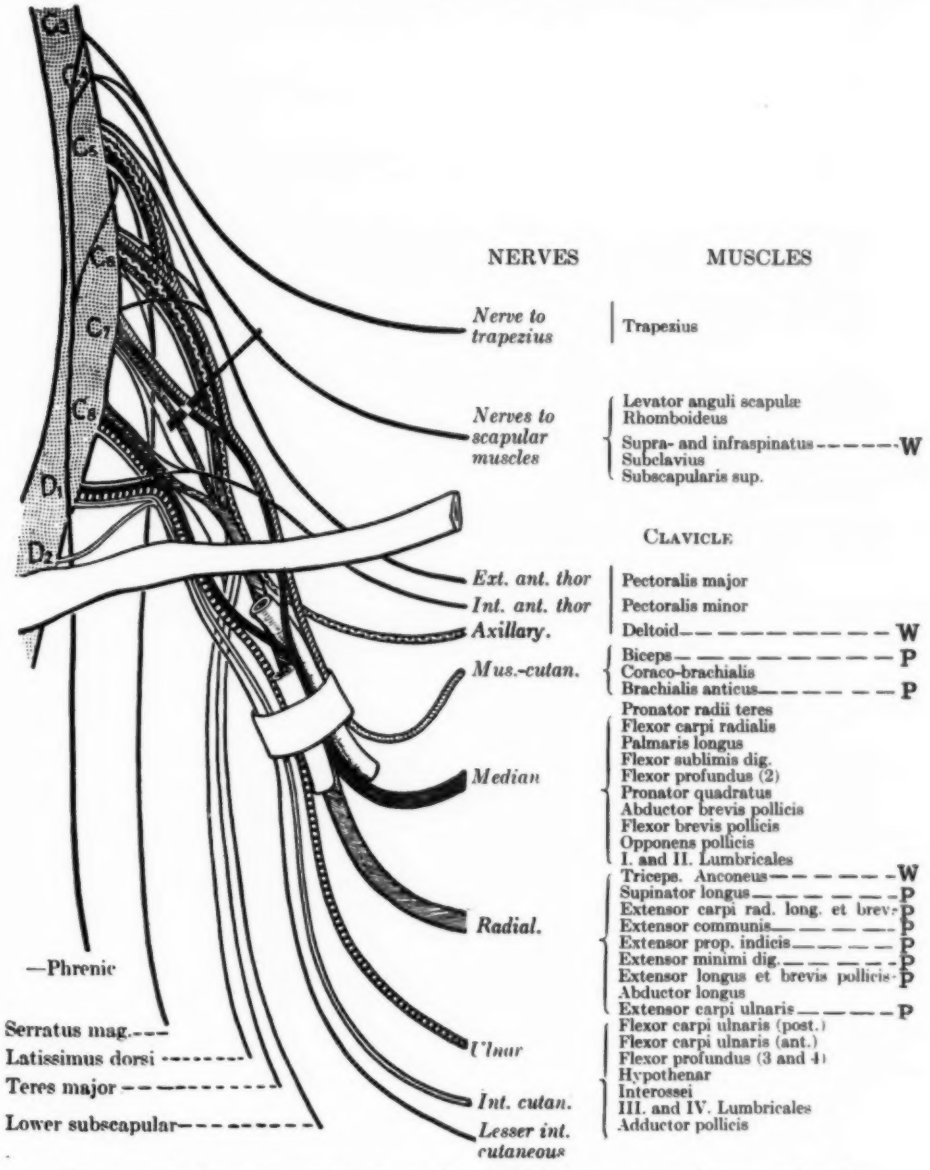

FIG. 233. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

a partial lesion of the upper and lower plexuses, usually at the level of the secondary cords.

Figure 235 illustrates a middle plexus lesion produced by an injury to the posterior secondary cord. There was a paralysis of the deltoid, triceps, supinators, extensors of the wrist,

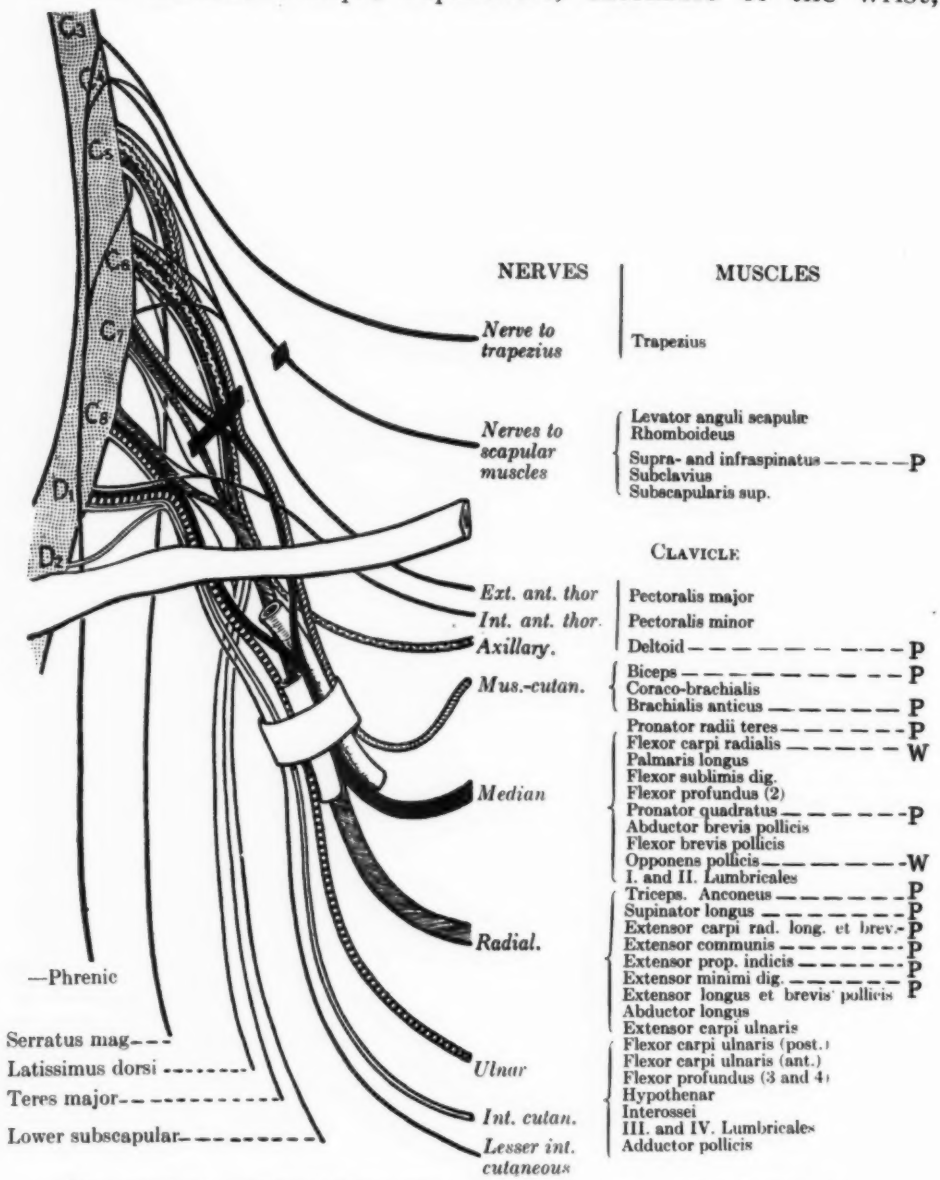
C3
C4
C5
C6
C7
C8
D1
D2
NERVES
MUSCLES
Nerve to trapezius
Trapezius
Nerves to scapular muscles
Levator anguli scapulæ
Rhomboideus
Supra- and infraspinatus ------P
Subclavius
Subscapularis sup.
CLAVICLE
Ext. ant. thor
Pectoralis major
Int. ant. thor
Pectoralis minor
Axillary.
Deltoid - - - - - - - - - - P
Mus.-cutan.
Biceps - - - - - - - - - - P
Coraco-brachialis
Brachialis anticus - - - - - - P
Pronator radii teres - - - - - - - P
Flexor carpi radialis - - - - - - W
Palmaris longus
Flexor sublimis dig.
Flexor profundus (2)
Median
Pronator quadratus - - - - - - - P
Abductor brevis pollicis
Flexor brevis pollicis
Opponens pollicis - - - - - - - W
I. and II. Lumbricales
Triceps. Anconeus - - - - - - - P
Supinator longus - - - - - - - - P
Extensor carpi rad. long. et brev. P
Extensor communis - - - - - - - - P
Radial.
Extensor prop. indicis - - - - - - P
Extensor minimi dig. - - - - - - - P
Extensor longus et brevis pollicis P
Abductor longus
Extensor carpi ulnaris
—Phrenic
Flexor carpi ulnaris (post.)
Flexor carpi ulnaris (ant.)
Flexor profundus (3 and 4)
Ulnar
Hypothenar
Interossei
Serratus mag- - -
Latissimus dorsi - - - - - - - -
Teres major- - - - - - - - - - -
Int. cutan.
III. and IV. Lumbricales
Adductor pollicis
Lower subscapular- - - - - - - - -
Lesser int. cutaneous

FIG. 234. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

fingers and thumb and in addition a weakness in the biceps, lumbricales and opponens pollicis.

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Figure 236 illustrates the combination of a posterior and outer secondary cord involvement. The deltoid, triceps, extensors of the wrist, fingers and thumb, the biceps, brachialis

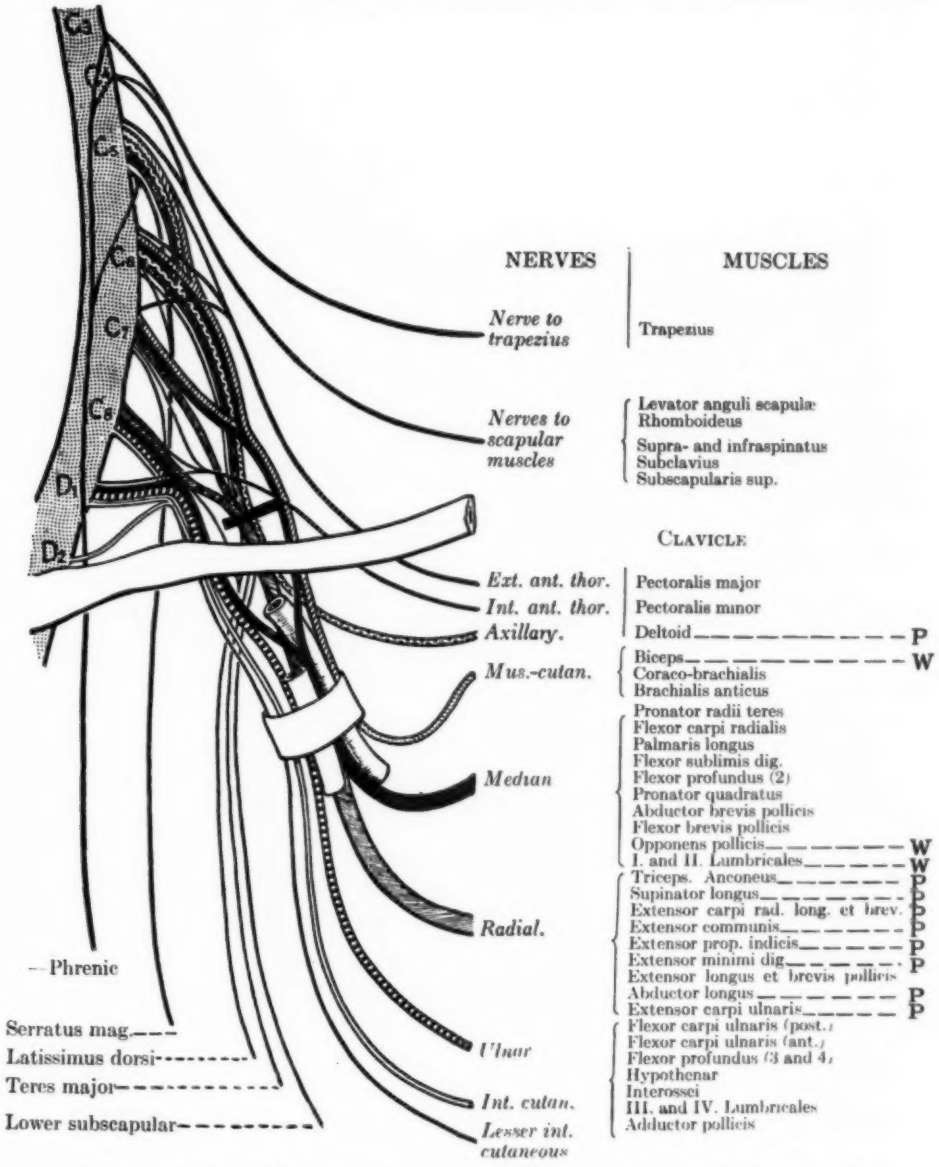

FIG. 235. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

anticus, the supinators, pronators, the flexor carpi radialis, and flexor sublimis digitorum were paralyzed. The pectorals and

latissimus dorsi were weak. Figure 237 represents a similar case. The deltoid, triceps, supinators, extensors of the wrist, fingers and thumb, biceps and brachialis anticus were paralyzed.

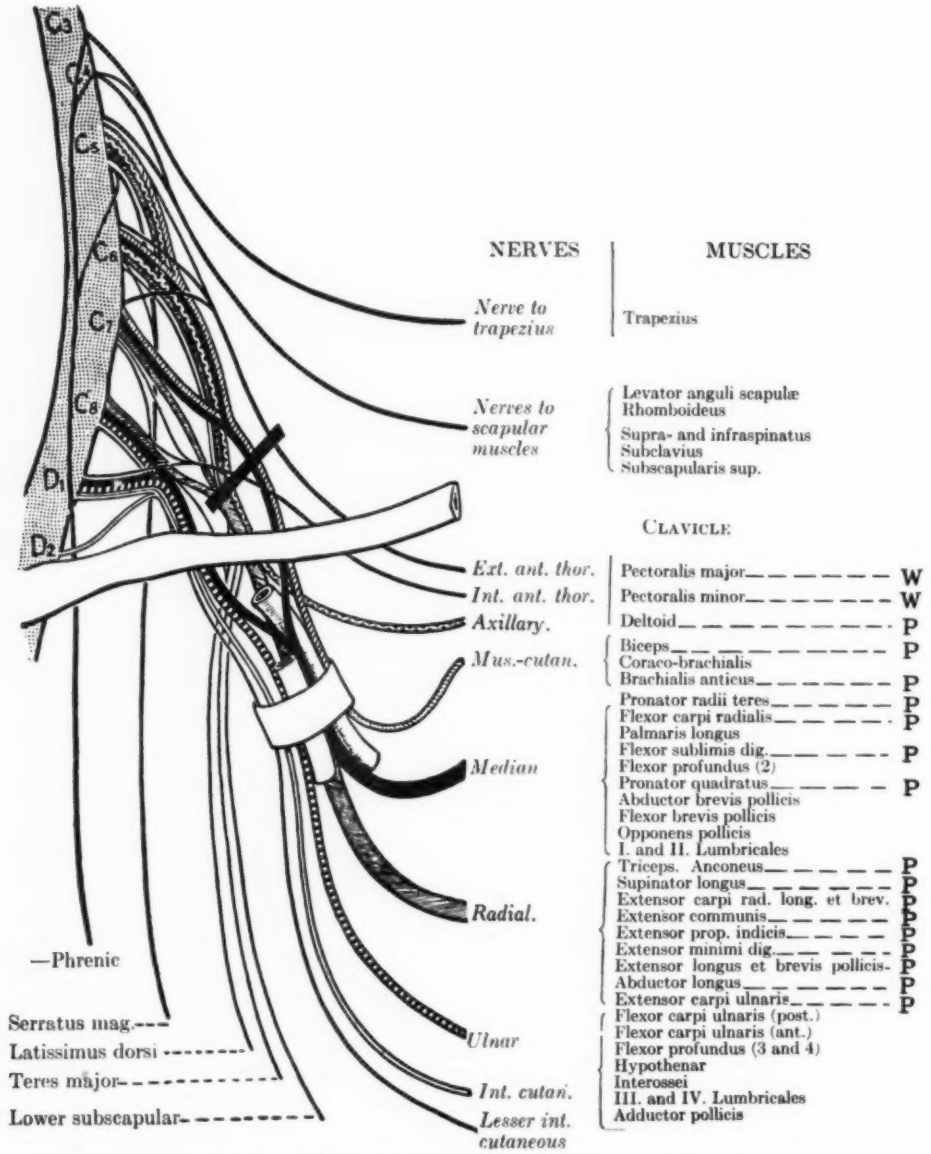

FIG. 236. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

Figure 238 shows an example of a partial lesion of the whole plexus, with a predominance of involvement of the

middle plexus. The extensors of the wrist, fingers and thumb, the interossei and lumbricales, serratus magnus, deltoid, pectorals, triceps, supinators, flexor carpi ulnaris, flexor sub-

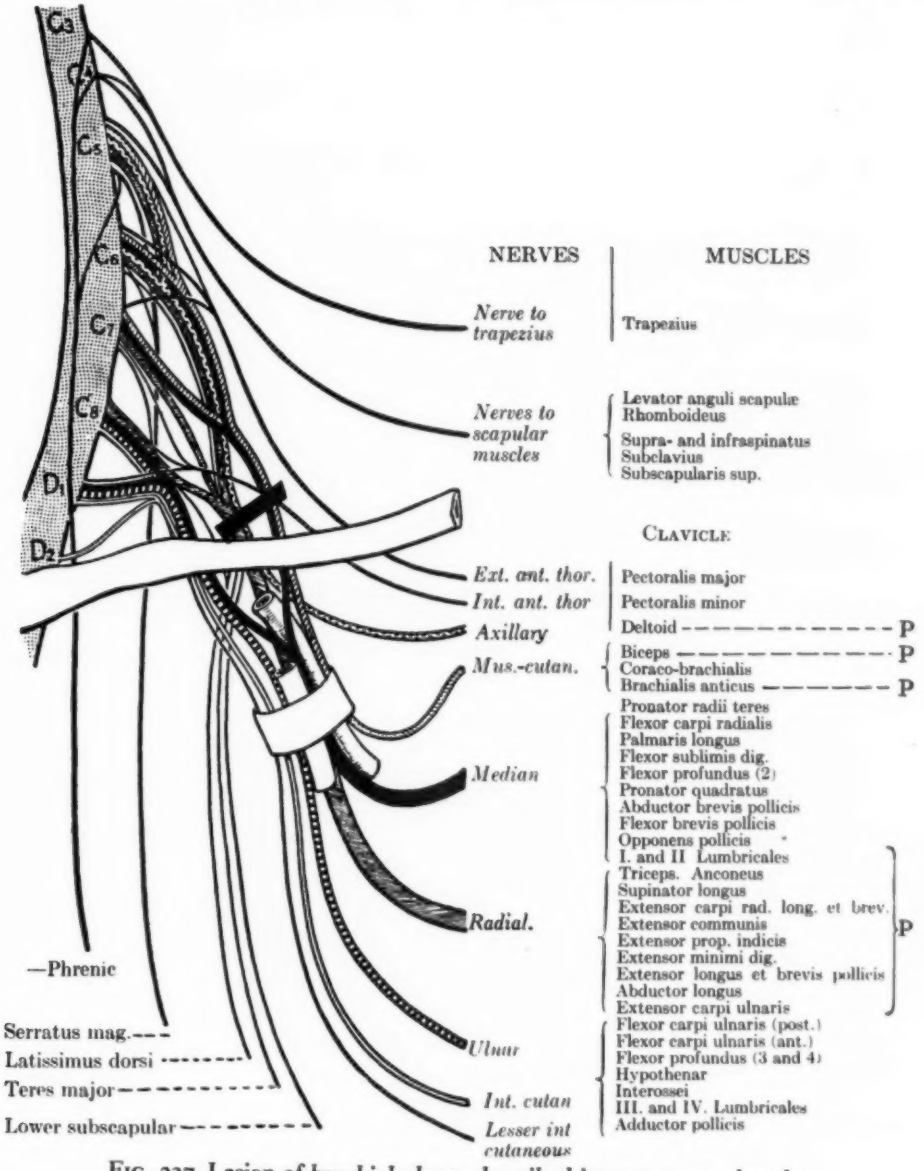

FIG. 237. Lesion of brachial plexus described in text. P, paralyzed.

limis and profundus digitorum, flexor brevis pollicis were paralyzed. The flexor longus pollicis and the thenar and hypo-

thenar muscles were weak. Figure 239 illustrates a similar case. There was a paralysis of all of the muscles supplied by the radial nerve and of the flexor carpi radialis, palmaris longus,

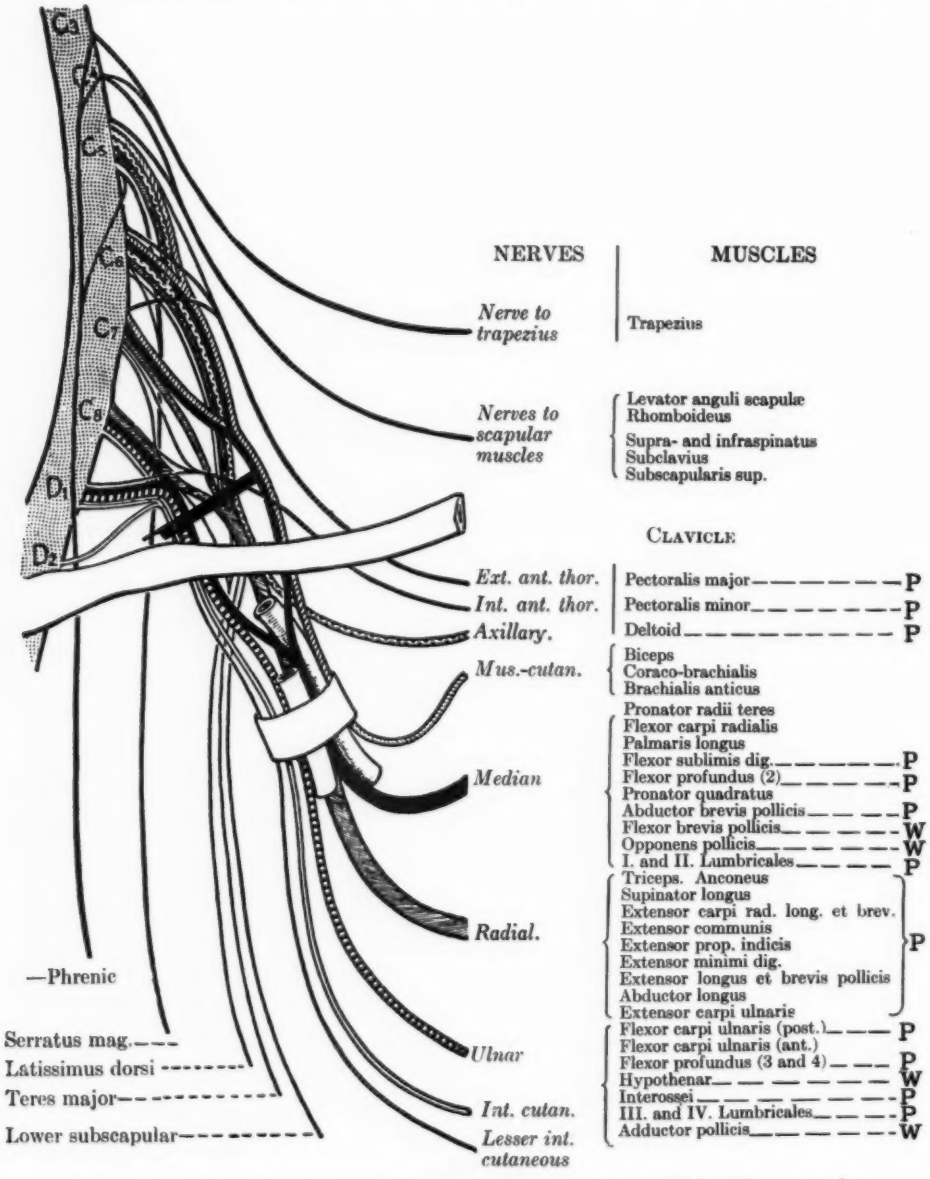

FIG. 238. Lesion of brachial plexus described in text. P, paralyzed. W, weak.

the hypothenar muscles, pronators and abductors pollicis. There was weakness in the biceps, the brachialis anticus,

flexor carpi ulnaris, flexor sublimis and profundus digitorum, interossei, lumbricales, flexor longus pollicis and opponens pollicis. Figure 240 represents another somewhat similar case

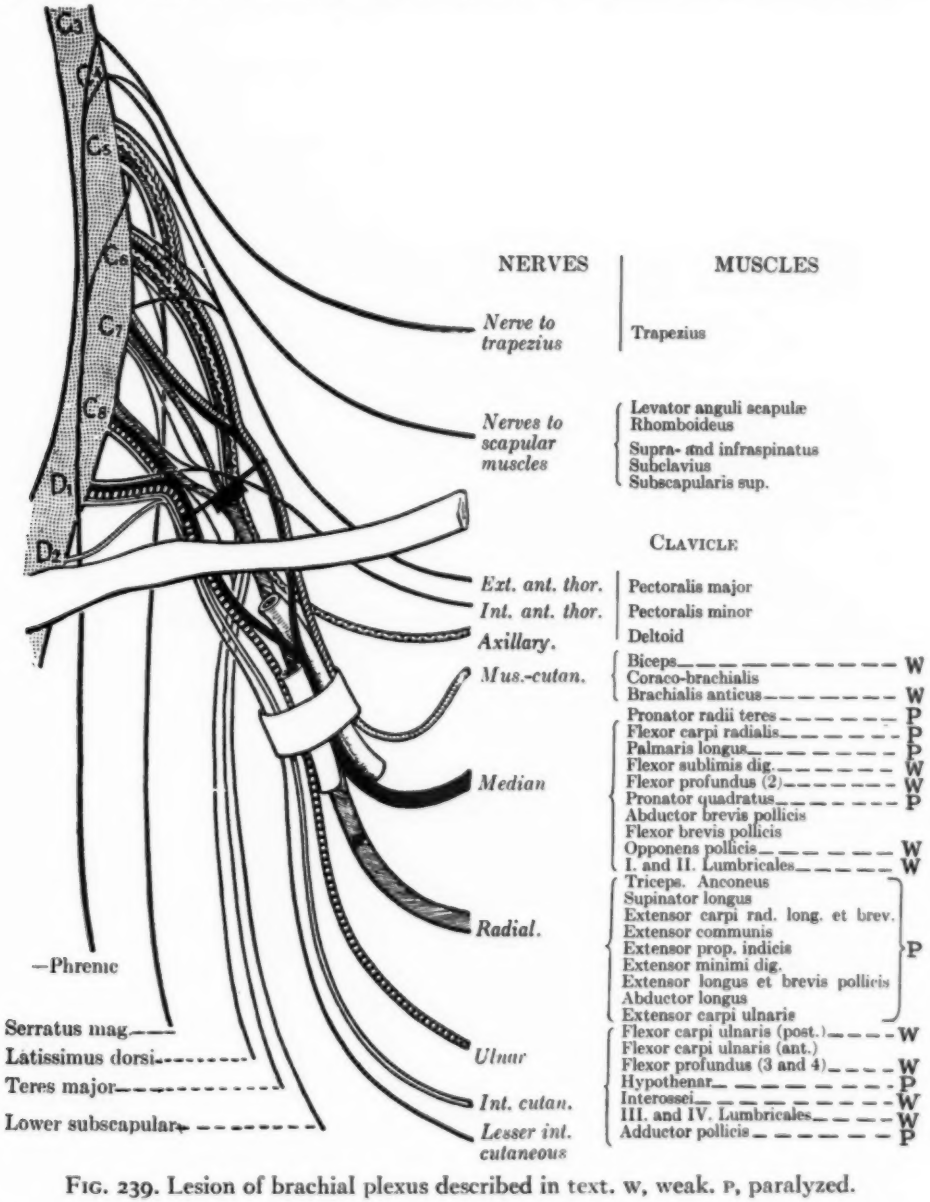

FIG. 239. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

in which the supinators, extensors of the wrist, fingers and thumb and all of the muscles supplied by the ulnar and median

nerves, excepting the pronators and flexor carpi radialis, were paralyzed. The last two muscles and the deltoid, biceps and triceps were weak.

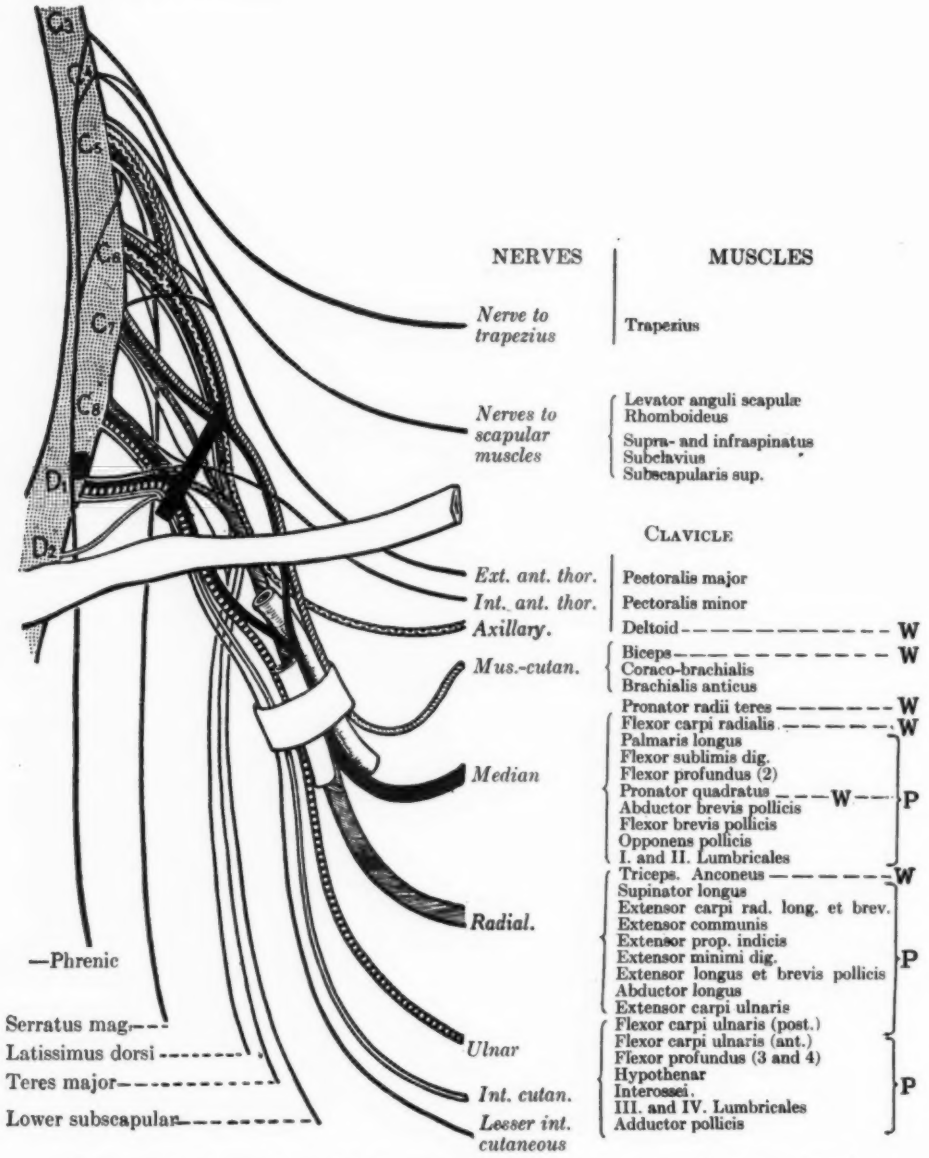

FIG. 240. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

No case of isolated injury to the eighth cervical or first dorsal roots was observed, nor were any cases of pure inner

cord injuries seen. When the lower brachial plexus was found injured, part of the middle plexus was also included in the lesion. Axillary wounds produced a lesion which commonly

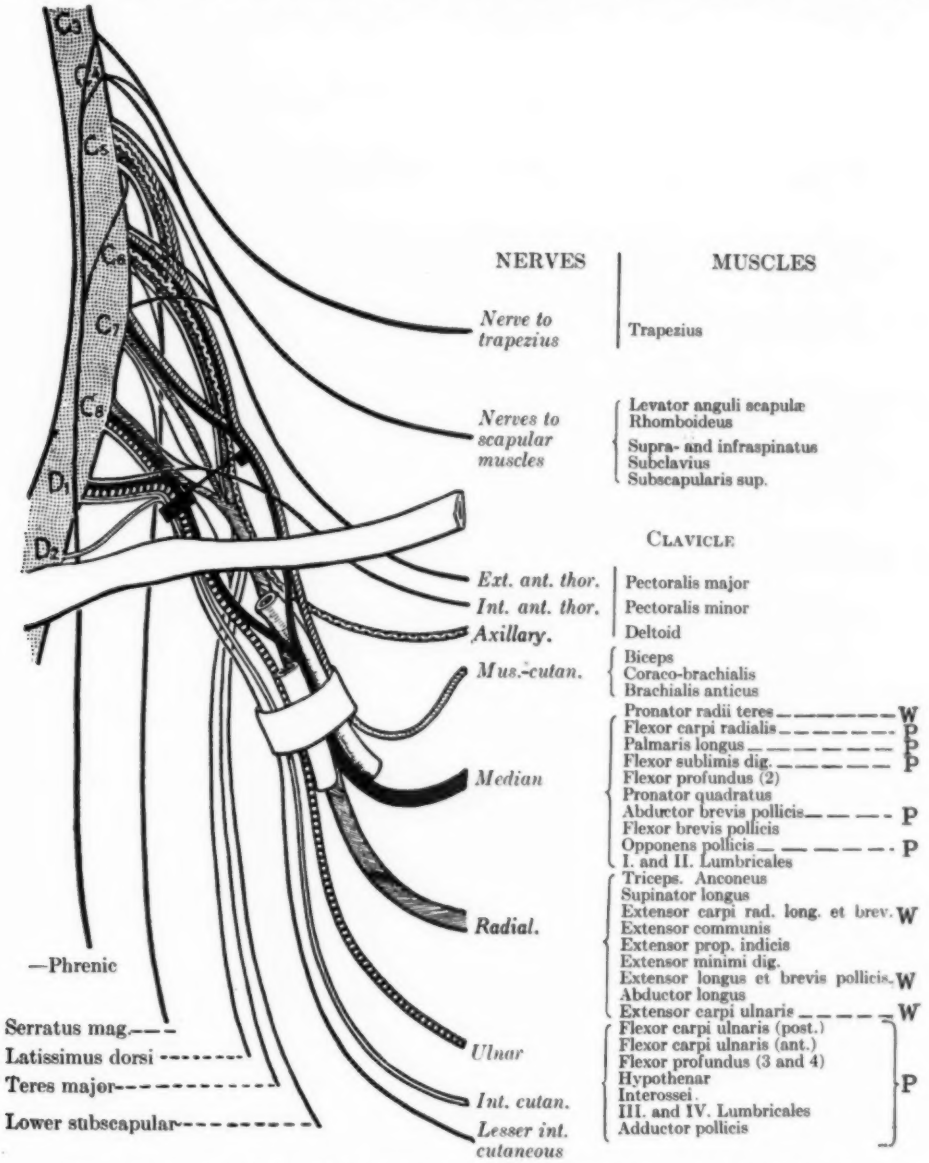

FIG. 241. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

involved the ulnar and median nerves; at times, in addition, the radial or the musculocutaneous, and rarely all of the peripheral nerves of the brachial plexus. The medial cutaneous

nerves of the arm and forearm rarely escaped. At times the injury occurred before the complete formation of the median nerve.

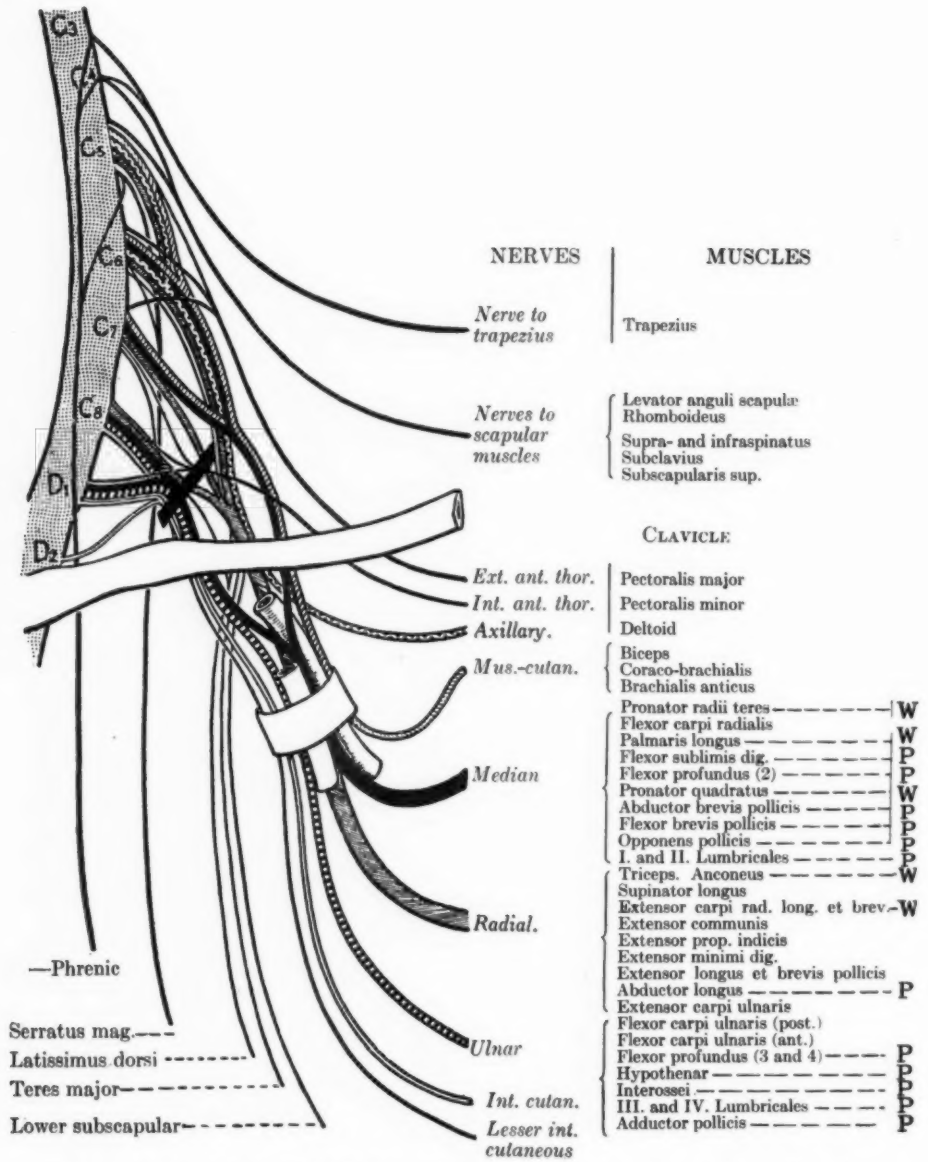

FIG. 242. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

In Figure 241 is illustrated an injury of the inner cord and middle plexus which produced a paralysis of all of the muscles

supplied by the ulnar nerve, the opponens pollicis, the short abductor of the thumb, the flexor longus pollicis, the palmaris longus, the flexor sublimis digitorum and the flexor carpi

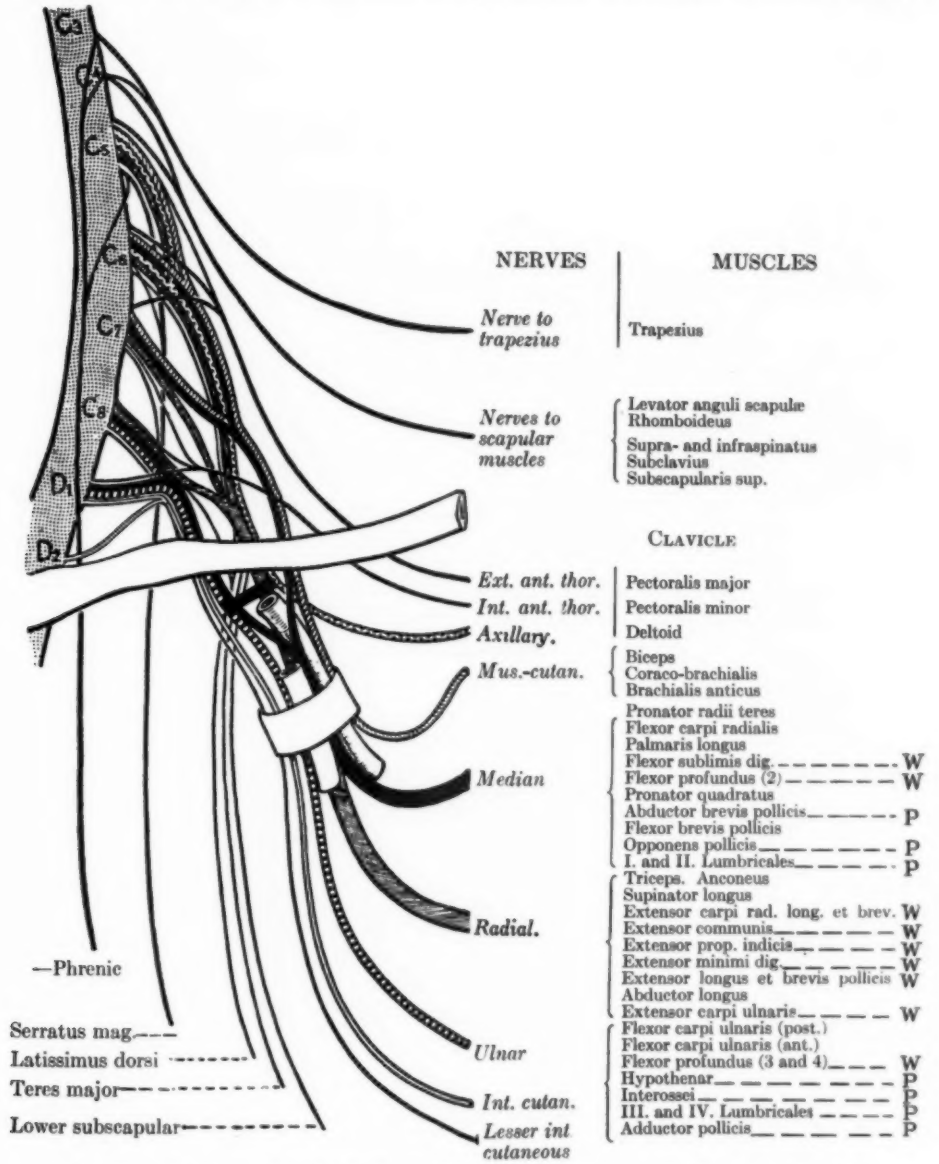

FIG. 243. Lesion of brachial plexus described in text. W, weak. P, paralyzed.

radialis. There was weakness of the pronators and of the extensors of the wrist and of the thumb.

In the case illustrated by Figure 242 there was a paralysis of all of the small hand muscles, the extensors of the fingers and thumb, the flexor longus and brevis pollicis, the flexors of

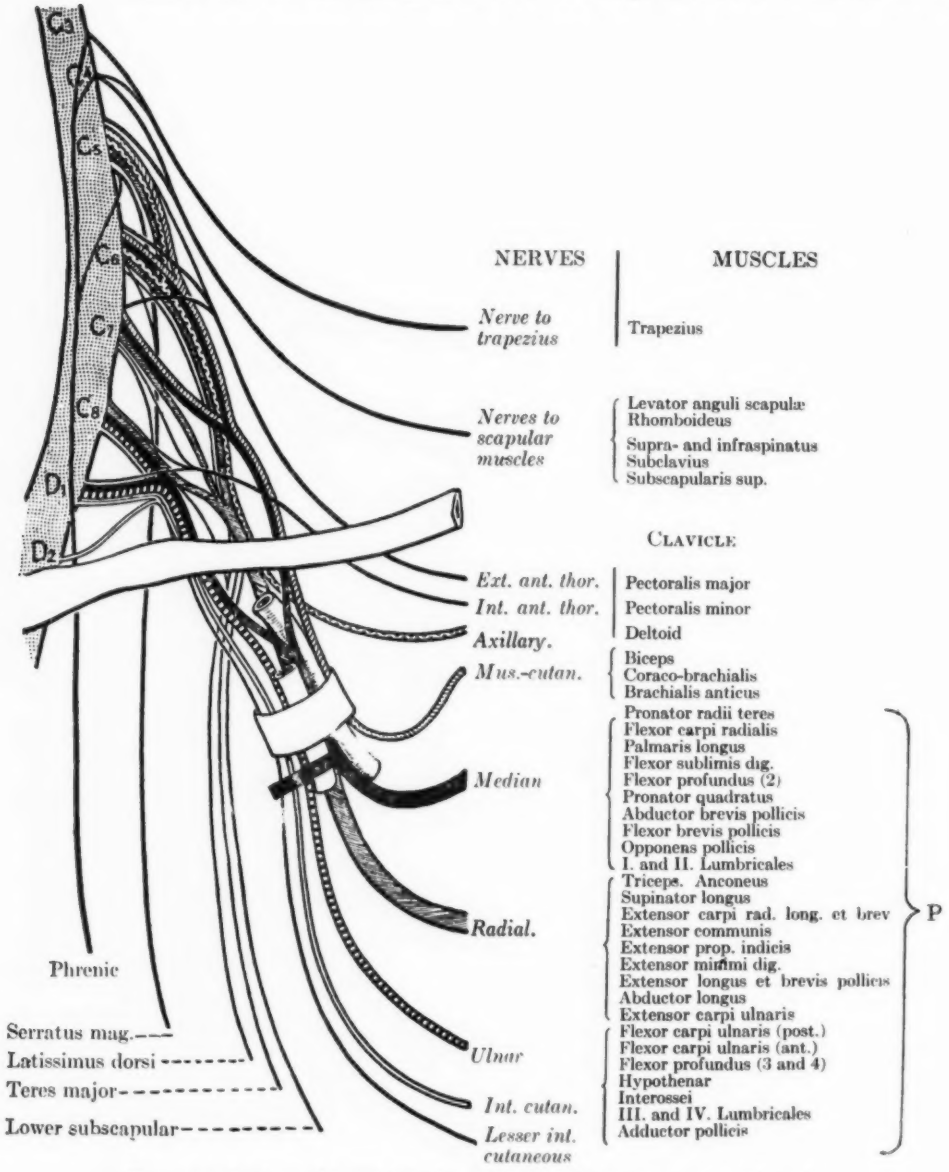

FIG. 244. Lesion of brachial plexus described in text. P, paralyzed.

the fingers, and a weakness in the triceps, extensors of the wrist, the pronators and palmaris longus. The sensory loss

occurred in the distribution of the eighth cervical and first dorsal segments only.

The outer head of the median nerve rarely escaped some

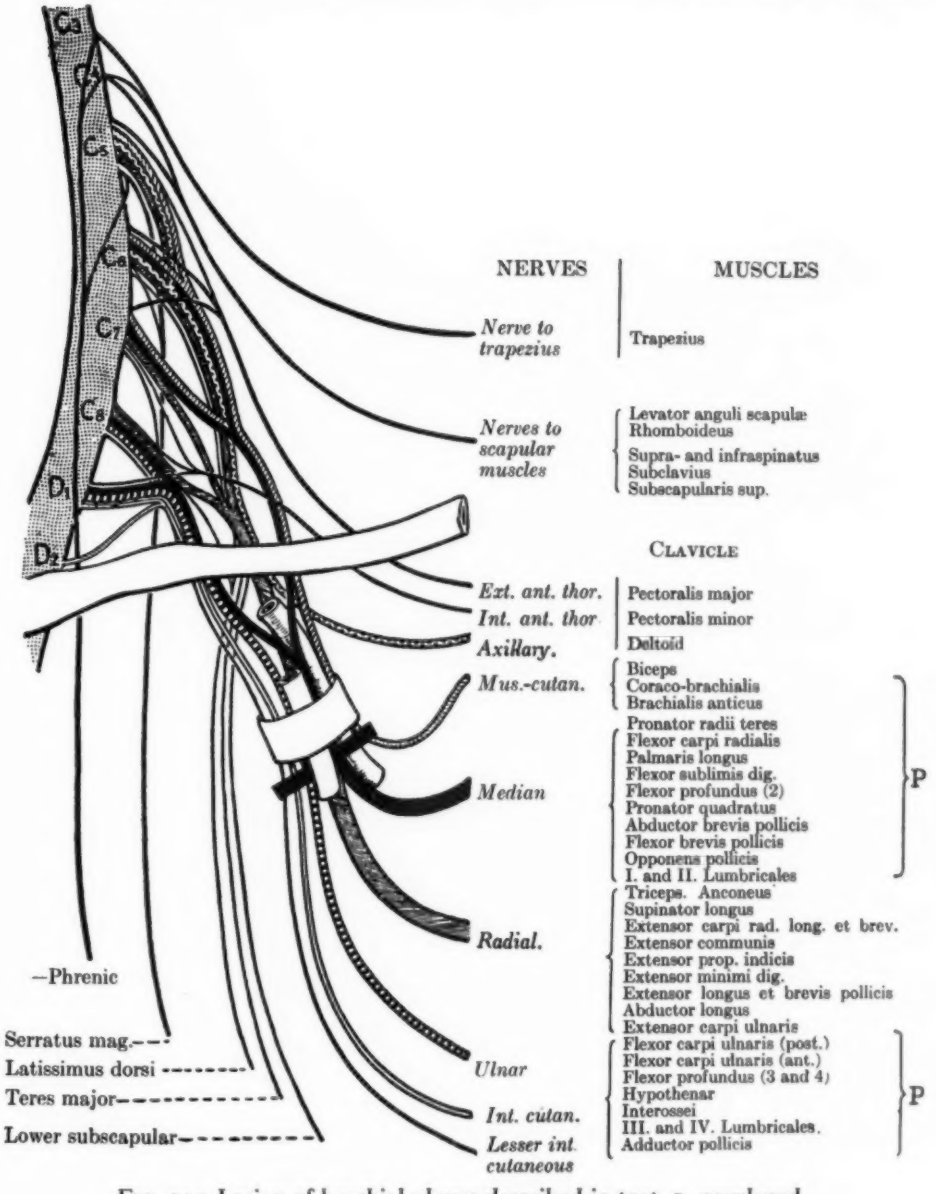

FIG. 245. Lesion of brachial plexus described in text. P, paralyzed.

injury in these lesions, although usually complete paralysis did not result. Occasionally it was entirely spared, as in the follow-

ing case (Fig. 243) in which a paralysis was seen in the small hand muscles, and the extensor longus pollicis. Slight weakness was present in the flexors of the fingers and marked weakness in

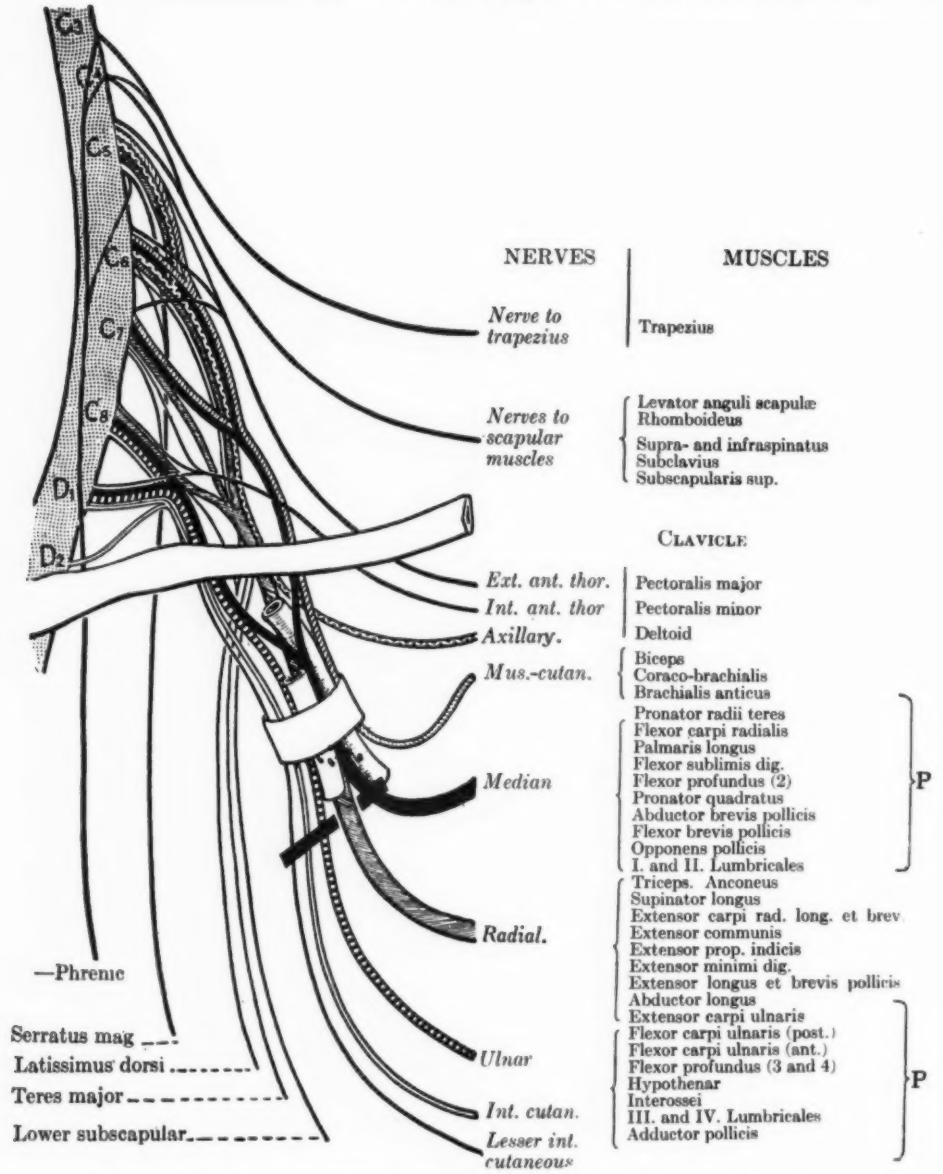

FIG. 246. Lesion of brachial plexus described in text. P, paralyzed.

the extensors of the fingers and wrist. The pronators and palmaris longus were spared. There was complete analgesia over the ulnar but none over the median distribution.

Axillary wounds produced lesions which corresponded in behavior to peripheral nerve injuries. The several nerves were injured in many combinations. Usually the ulnar, median and medial cutaneous nerves to the arm and forearm were injured together. At times the radial and rarely the musculocutaneous were likewise involved.

Figure 244 illustrates a case with paralysis of all of the muscles supplied by the ulnar, median and radial nerves. There was sensory loss over the medial cutaneous nerves of the arm and forearm.

Figure 245 illustrates a case in which the ulnar, median and musculocutaneous nerves were severed, and sensory loss was present over the medial cutaneous nerves of the arm and forearm.

Figure 246 represents a case in which the ulnar and median nerves were severed and sensory loss occurred over the distribution of the medial cutaneous nerves of the arm and forearm.

A few interesting observations may be made from the study of motor disturbances. Intravertebral root lesions occurred only when evidence of spinal cord injury existed. Paralysis of the latissimus dorsi and pectoral muscles occurred more frequently when the primary cords were injured. The supinators frequently escaped in a lesion which corresponded to the fifth cervical root. Lesions of completely formed nerves and of roots produced complete paralysis, whereas other lesions produced incomplete paralysis. In middle plexus lesions when the median nerve was slightly injured the opponens pollicis seemed to be the most vulnerable muscle.

A narrowed palpebral fissure, small pupil and enophthalmos, which were a part of the symptom-complex of the brachial plexus lesion described by Mme. Klumpke-Dejerine result primarily from injury to the eighth cervical or first and second dorsal roots. They are seen far more commonly in the brachial plexus injuries due to birth injury. When these symptoms are due to an injury of the cervical sympathetic chain, vasomotor disturbances and facial anhidrosis occur as well. This constitutes a Horner's syndrome.

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